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Pre-feasibility study for rural electrification in Orissa, through renewables

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1 Background

With the recent ongoing growth of global environment issues, Japan has decided to ensure long-term, stable energy supply/demand and prevent increasing energy consumption from affecting the global environment. To appropriately meet these goals, Japan is considering to assist developing countries to save energy by providing efficient energy-enhancing technology, as well as, introducing new sources of energy such as sunlight, wind power, and biomass.

India, which is one of the largest energy-consuming countries in Asia and is expected to consume more energy in the future. This study sponsored by M/s Mitsubhishi Research Institute, Japan to explore the feasibility of popularizing oil-replacement energy, which is expected to conserve energy from fossil fuels and help solve the current problems. The study results will be reflected in future projects.

Specifically, the study covers the effective use, in Orissa, India, of a distributed energy system that uses biomass resources, such as crop wastes and wood wastes.

In particular, India plans to effectively use biomass resources, such as agricultural and crop residues, as a clean energy replacement for fossil fuel energy including diesel oil. The study considered to of greater importance because of the advanced, technological assistance provided by Japan.

1.1 Scope of the work

The project will result in the formulation of the proposal for implementation of an oil replacement energy technology based decentralized heat and power generation in the identified potential villages of Orissa.

The following is the list of activities envisaged to undertaken in order to achieve the project objectives

- Collecting Basic Information to Select the Area for Project Promotion
- Selecting the Area for the Project

- Collecting Data Regarding Biomass Energy Consumption in the Selected area
- Studying the Technological Feasibility of the Project
- Studying the Sustainability (Implementation, Operation, and maintenance) of the Project
- Comprehensively Evaluating the Project

2

About Orissa

The state Orissa is situated in east coast of India and surrounds by state of Madhya Pradesh, Bihar, Bengal and Bay of Bengal.The state covers an area of 155707 sq.kms and having the population of 30,151,270 according to 1991 census figures. Agriculture sectors being a major source for employment generation. The state contributes about 1/10 of the rice produced in India, which makes a significant contribution to India's rice productivity. The major crops in Orissa were oil seeds, sugar cane, tobacco, jute, and cotton.

Orissa is one of the richest states of India intermes of natural resources such as minerals, its reserves such as iron ore, manganese ore, chromate, limestone, graphite are among the best in India.

Orissa can be broadly classified into two clear-cut natural divisions one as the coastal Plain and the other as the northwestern Plateau. The coastal plain varies in width except in Southern Ganjam District where the Eastern Ghats are the highest (1500 meters above sea level) and lies close to the sea. A very large river, Mahanadi crosses this plain and its big delta merges into the deltas formed by the Brahmini and Baitarani. These deltas are fertile and are provided with irrigation facilities. All these rivers being filled with enormous water and sometimes cause dangerous floods during the rainy season. But during the dry seasons, their channels are almost dry.

The table-1 of general information shows the Geo-physical Indicators of state and the administrative set up etc of the state.

Table-1 General Information

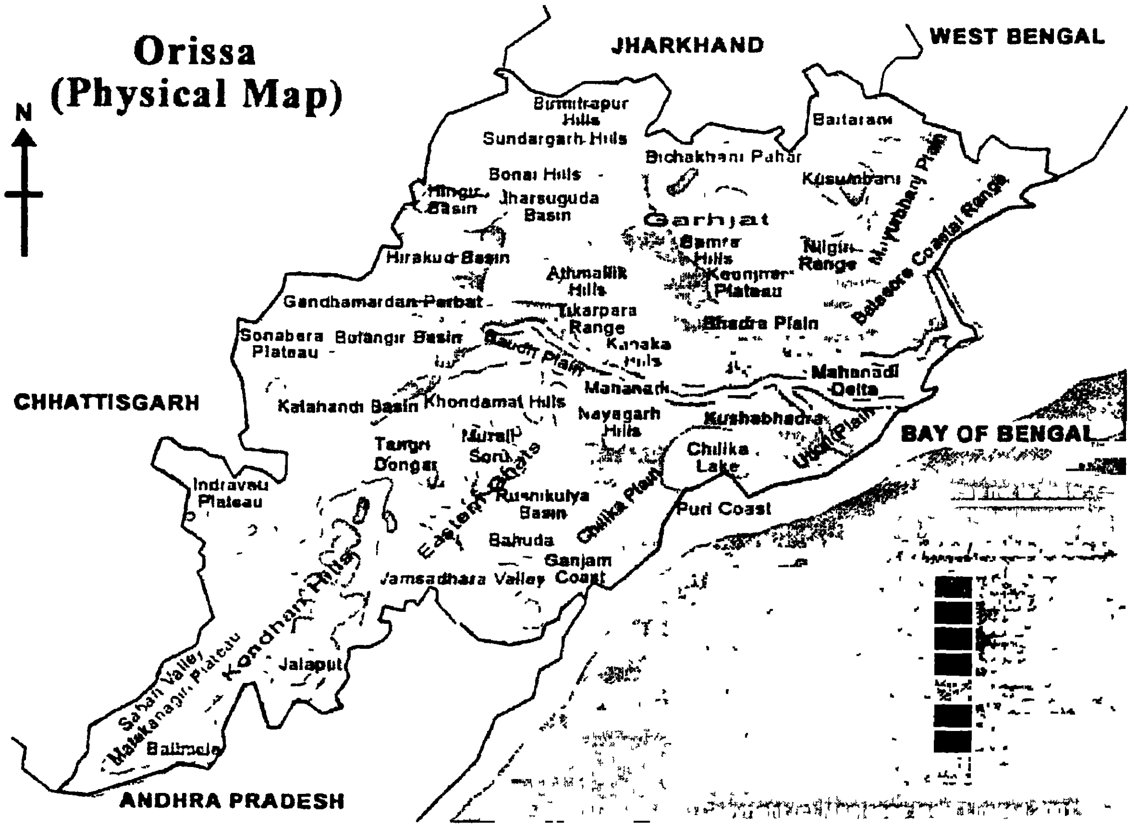
GEO-PHYSICAL INDICATORS	
Longitude	81° 29'E - 87° 29'E
Latitude	17° 49'N - 22° 34'N
Actual Rain Fall (1997)	1463 3 M.M
Normal Rain Fall (1997)	1482 2 M M

Table-1 General Information contd

ADMINISTRATIVE SET-UP	
No. of Districts	30
No of Blocks	314
No. of G.P's	5263
No. of Villages	
Inhabited	46989
Uninhabited	4068
Total	51057
No. of Sub Divisions	58
No of Tahasil	148
No of Towns	123
No. of Municipalities	31
No. of NACS	70
No of Police Stations	442
No of Fire Stations	98
No of Assembly Constituency	147
GEOGRAPHIC INDICATORS	
Rural population (Census 1991) in '000 No	27425 (87%)
Urban population (Census 1991) in '000 No.	4235 (13%)
Total Population (Census 1991) in '000 No	31660
Male	16064 (50.7%)
Female	15596 (49.3%)
Sch Caste	5129
Sch Tribe	7032
Sex Ratio (Female / Male)	971 / 1000
Population Density	203 per Sq. Km

.1 Socio-economic status

The socio-economic background of Orissa, which consists of 4.74% of India's total landmass and with 36,706,920 people according to 2001 Census, which accounts for 3.57% of the total population. Nearly 87% of the population lives in rural areas and largely dependent on agriculture for their livelihood. The state holds abundant resources of minerals including precious and semi-precious stones. As this state also holds abundant water resources, according to the estimate of the Central Ground Water Board in 1992, the total replenishable ground water resources from normal recharge in Orissa were 16,48,573 hectaremeter The gross annual draft in 1992 was 1,66,875 hectaremeter. As per the statistics available the state is harnessing a very low i.e. 10 12 per cent of ground water resources. The total cultivatable land of the state is nearly 65.59 lakh hectare of which only 38 per cent i.e. 24.85 lakh had been used for irrigation till end of 1999-00. Properly Planned programs for exploitation and for optimum utilization of the resources such as rich mineral, land, water and other resources including human resources holds the key to rapid economic development of the state. Annuxere-1 show's States Socio-economic status such as population distribution, density, percentage forest area etc. The Map-1 shows the various districts of Orissa and their attitudes with level to sea level.



Map 1 Orissa (Physical map)

2.2 Agriculture

Agriculture continues to be the backbone of the State's economy with contribution of about 30% to Net State domestic product (NSDP) during 1998-99. Taking into the high contribution of this sector to the State's income and the large percentage of people dependent on this sector. The State Government have formulated the Agricultural Policy 1996 with the main objectives of doubling the production of food grains and oilseeds by the end of the Ninth Plan, to adopt agriculture as the main route for eradication of poverty. The Agricultural Policy 1996 is expected to provide boost to this sector for all-round development of this sector by a status of industry to Agriculture under the new agricultural Policy. According to agricultural Census conducted by the board of revenue, there were 39.48 lakh operational holdings in Orissa in 1990-91 of which small and marginal holdings accounted for 79.88% while the remaining 20.12% came under the category of semi-medium, medium and large holdings. As much as 46.66% of the total operated small and marginal farmers and the remaining 53.34% by the semi-medium, medium and large farmers owned area.

Agriculture occupies a vital place in the economy of the State like Orissa. While Agriculture and Animal Husbandry contributed 32.88 percent of the Net State Domestic Product of the State in 1999-00, the Agriculture alone provide direct and indirect employment to around 64 percent of the total work force of the State as per the 1991 Census.

Agriculture in Orissa continues to be characterized by low productivity to traditional agricultural practices, inadequate capital formation and low investment, adequate irrigation facilities and uneconomic size of holdings. Nearly 62% of the cultivable land is rained and exposed to the vagaries of monsoon. The per capita availability of cultivated land, which was 0.39 hectare in 1950-51, has declined to 0.17 hectare in 1999-00. The State has around 31.54 lakh small and marginal farmers accounting for 79.88% of the total operational holdings. These farmers do not have the means to make appropriate investment in agriculture due to poverty.

The average yield rate of rice in Orissa, which was 12.12 quintal/hect in 1998-99, decreased to 11.27 quintal/hect during 1999-00. Over-dependence of monsoon and low application of recommended inputs are the two major factors responsible for low productivity of rice in Orissa. The per capita availability of food grains per annum, which was 198 kg in 1995-96, decreased to 154 kg in 1999-00. The contribution of Orissa to the food grain basket of the country is estimated at 2.70% in 1999-00. Orissa has vast potential for development of horticulture. Different agro-climatic zones have been identified for development of specific fruits, vegetables and spices. Hill tracts of KBK districts and of Phulbani and Gajapati districts are suitable for intensive horticultural activities. Annexure-2 shows the Land utilization pattern in Orissa.

In the absence of adequate irrigation facilities, agriculture is pathetically dependent upon monsoon. As a result of the erratic behavior of the monsoon, agricultural production fluctuates widely from year to year. The net irrigation potential created by the end of 1999-90 from all sources was 24.85 lakh hectare, which is 42.12% of the total irrigatable area of the State. Out of 24.85 lakh hectare of irrigated area, 11.56 lakh hectare of land are irrigated through major and medium irrigation projects, 4.41 lakh hectare through minor (flow), 3.31 lakh hectare through minor (lift), and 5.58 lakh hectare through other sources which include private tanks, ponds, dugwells, water harvesting structures and the like. However, assured irrigation is available through major and medium irrigation projects, which accounts 46.52%. This underscores the need for boosting the assured irrigation potential in order to insulate agriculture from the vagaries of monsoon.

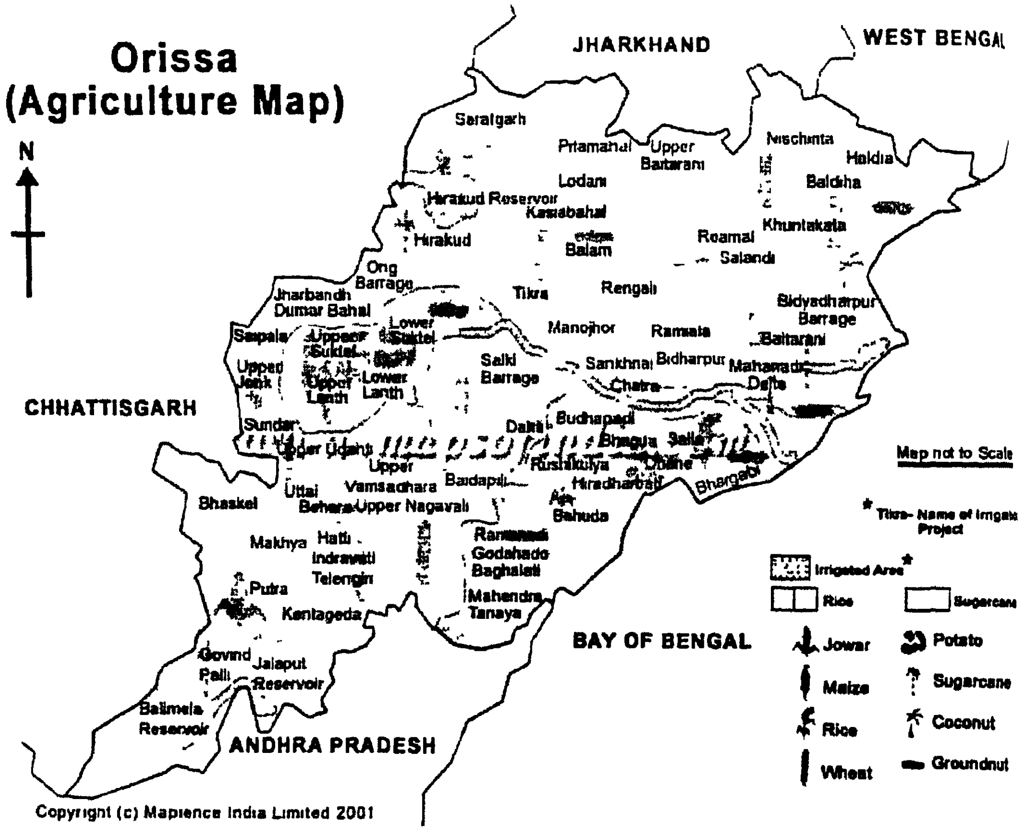
Inadequate of assured irrigation in the State has been a major bottlenecks in the development the agricultural sector. Nearly 62% of the cultivable land is rainfed and exposed to vagaries of monsoon. Erratic and uneven distribution of rainfall affects agricultural production adversely. The State Government has therefore assigned high priority to optimum utilization of both surface and ground water. Annuxere-3 shows the Cropping pattern of principal crops in Orissa.

The State has 65.59 lakh hectares of cultivable land of which 59.00 lakh hectare can be brought under assured irrigation through different types of sources of irrigation. Annuxere-4 shows the Yield rate of Principal Crops in Orissa

By the end of the Eighth Plan (1996-97), 23.44 lakh hectares of net irrigation potential had been created through all sources which constitutes 39.73% of the estimated irrigatable land. It is proposed to provide irrigation facilities to 11.60 lakh hectares of additional agricultural land from different types of sources during the Ninth Plan period as shown below in the table –2. Map –2 shows irrigated area and different types of crops in Orissa

Table-2 Ninth Plan period statistics

		Lakh hectare
1	Major and medium irrigation projects	5.30
2	Ground water (dug wells, shallow tube wells etc.)	1.30
3	Minor irrigation (flow and lift)	3 00
4	Water harvesting structures etc	2 00
	Total	**11. 60**



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Map 2 Orissa Agricultural map

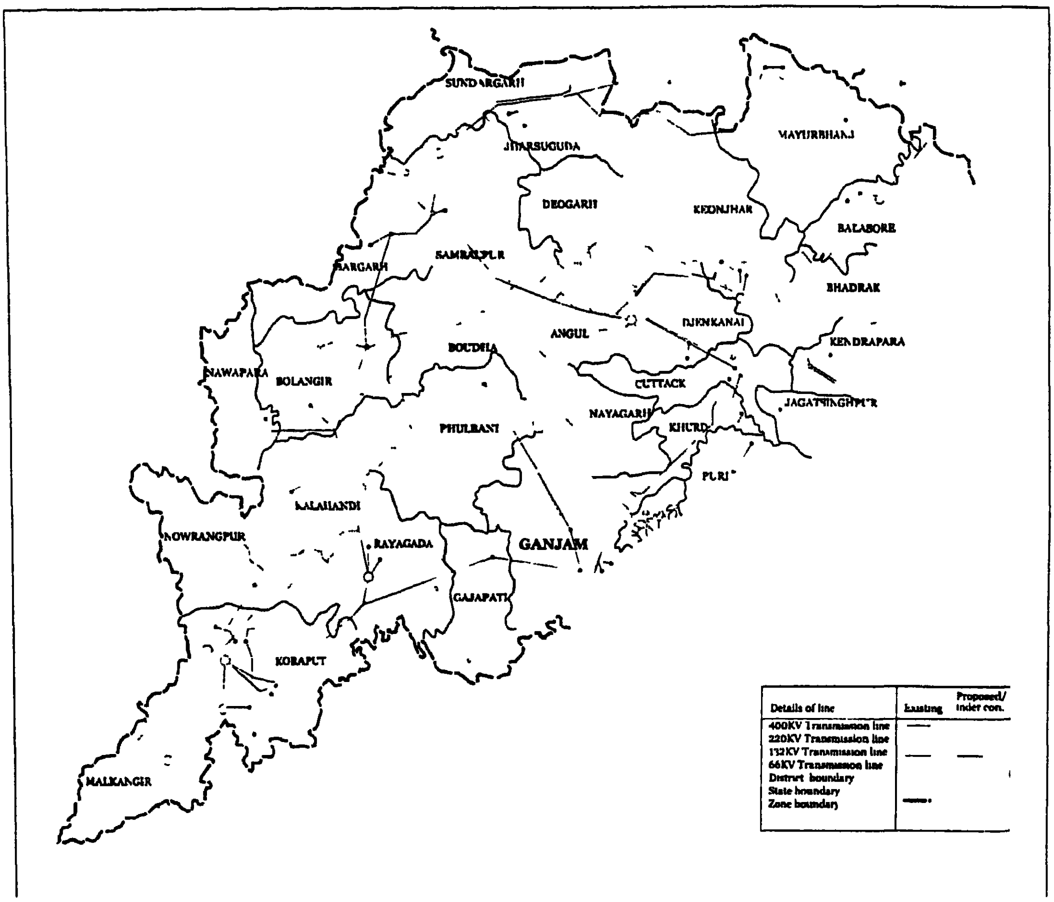
2.3 Power

Adequate availability of power is essential for sustained growth of the economy and because the main objectives of this sector are utilization of the power generated in an optimum manner and plan for adding to generation for meeting the anticipated increase in demand for power over the coming years.

With the enactment of Orissa Electricity Reform Act, 1995, Orissa became the first State in the country to initiate reform and restructuring of power sector. Reforms in the power sector have been implemented with the restructuring of the erstwhile Orissa State Electricity Board (OSEB) and establishment of an independent Regulatory Commission to improve the overall efficiency of the system. The functions of OSEB were entrusted to two new corporations namely (i) Grid Corporation of Orissa (GRIDCO) (ii) Orissa Hydro Power Corporation (OHPC) on 1st April 1996. The existing transmission and distribution system was transferred to GRIDCO all hydro power stations including projects under construction were transferred to OHPC. OPGC, which was incorporated in 1984, is looking after the thermal power projects in the State. The State Government at present wholly owns OHPC. However in respect of OPGC, 49% of equity was disinvested in 1998-99.

The distribution function of GRIDCO was separated in November 1997 and four distribution companies namely Central Electricity Supply Company of Orissa Ltd. (CESCO), North-Eastern Electricity Supply Company of Orissa Ltd. (NESCO), Western Electricity Supply Company of Orissa Ltd (WESCO) and Southern Electricity Supply Company of Orissa Ltd (SOUTHCO) were incorporated as wholly owned subsidiaries of GRIDCO. GRIDCO disinvested 51% equity each in WESCO, NESCO and SOUTHCO in favor of M/s Bombay Suburban Electricity Supply Company Ltd (BSES) and disinvested 51% equity in CESCO in favor of a consortium between M/s American Electricity Supply Company Ltd. (AES) and M/s Jyoti Structure Ltd. The equity of GRIDCO in each of these companies now is at the level of 39% and the remaining 10% are held by the Employees Welfare Fund. GRIDCO is the sole transmission licensee for supply of power in Orissa and is at present wholly owned by the Government of Orissa.

The estimated demand for power in the State for the year 1999-00 was about 1270 MW. The demand for power is increasing and is expected to reach 2150 MW in year 2001-2002. It is proposed to meet this additional requirement through a series of measures, which include creation of additional generating capacity, demand side management, reduction of transmission and distribution losses and renovation of old units. Keeping these objectives in view, it has been decided to invest more funds in the power sector. Accordingly, the Ninth Plan outlay has been projected at Rs 4622.79 crore while the Annual Plan for 2000-01 envisages an outlay of Rs 818.22 crore. The Map-3 shows the details of power lines existing and proposed in Orissa.



Map-3 Details of power lines existing and proposed in Orissa

At the end of 1999-00, the states share in the total installed capacity from the hydropower projects in the State sector was 1618.88 MW from which power generation was 551.66 MW. Similarly, the total installed capacity of the existing thermal power projects in the State was 880.00 MW with power generation of 556 47 MW. Thus the State's share in the total installed capacity in the State sector was 2498.88 MW which generated 1108.13 MW of power during 1999-00. In addition, Orissa's share of the installed capacity in Central sector projects was 262.00 MW. These Central sector projects supplied 559.91 MW of power to the State during 1999-00. Thus, the total installed capacity available for the State was 2760.87 MW, which generated 1668 04 MW of power from captive power plants installed in 1999-00, the State also purchased 79.16 MW of power from captive power plants installed in the State by different industries against 115.94 MW of power purchased in the previous year.

The demand for power in the State has been increasing rapidly due to increasing industrialization, urbanization, and rural electrification. The estimated demand for power has increased from 1114 MW during 1995-96 to 1270 MW during 1999-00, showing an increase of 14.00% over the period The consumption of power in the State has decreased to 5431 million units (MU) in 1998-99 from 5571 MU in the previous year. The energy consumption in the domestic sector has increased from 1609 MU during 1997-98 to 1713 MU during 1998-99 The total energy consumption of the industrial sector also decreased from 2829 MU during 1997-98 to 2521 MU during 1998-99 excluding power consumption by industries like NALCO, RSP, HPCL and ICCL etc. which used power from their own captive power plants. The grid map of the state is given in the figure showing network of 66kV line and above.

2.4 Rural electrification

Out of 46,989 inhabited villages in the State, 35,190 villages have been electrified by the end of 1999-00, representing coverage of 74.89%. Table-3 shows the Number of Villages Electrified in Orissa over the period from 1996-97 to 1999

Table-3 Number of Villages Electrified in Orissa over the period from 1996-97 to 1999-00

Sl.No	Year	Number of Villages electrified		
		During the year	By the end of the year (Cumulative)	Percentage to total villages
1	1996-97	737	32,825	70.00
2	1997-98	800	33,625	71.56
3	1998-99	817	34,442	73.43
4	1999-00	748	35,190	74.89

Source GRIDCO, Bhubaneswar

It is proposed to electrify about 6000 villages which are located less than 7km from the grid are to be electrified through the grid extension and the remaining villages through districts wise, as per the table "states of unelectrified villages" given in the table–4,through renewables. The Rural Electrification works are to be taken up by four Distribution Companies in the State; the status of village electrification is shown in the table-5 i.e. ESCO/NESCO/WESCO/ SOUTHCO as GRIDCO has been divested of its distribution activities consequent upon the reform process. Table-6 shows the Progress of Rural Electrification and Energization of Pump Sets in the State.

Table-4 District wise details of un-electrified villages in the State

S No	District	Blocks	Inhabited villages	Un-Electrified villages	In Hilly area	In forest area	On river side	In other areas	Within 3 Kms from the grid	Within 4-7 Kms from the grid	Beyond 7 Kms from the grid
1	Angul	8	1635	407	28	163	2	214	239	142	26
2	Balasore	12	2586	207	-	-	-	207	14	60	133
3	Bargarh	12	1177	20	-	20	-	-	4	2	14
4	Bhadrak	7	1224	214	3	83	-	128	1	123	90
5	Bolangir	14	1761	127	-	109	-	18	43	61	23
6	Boudh	3	1101	461	-	-	-	461	155	20	286
7	Cuttack	14	1865	31	-	-	-	31	13	11	7
8	Deogarh	3	697	403	14	137	-	252	302	75	26
9	Dhenkal	8	1060	118	-	75	2	41	66	42	10
10	Gajapati	7	1460	808	85	58	8	657	111	327	370
11	Ganjam	22	2762	341	30	-	123	188	16	159	166
12	Jagatsinghpur	8	1207	85	-	-	-	85	-	51	34
13	Jajpur	10	1560	111	-	-	-	111	-	44	67
14	Jharsuguda	5	353	7	-	6	-	1	6	1	-
15	Kalahandi	13	2068	865	40	641	-	184	160	384	321
16	Kandhamal	12	2336	1144	321	85	-	738	134	631	379
17	Kendrapara	9	1389	119	-	5	-	114	-	81	38
18	Keonjar	13	2067	318	-	-	-	318	6	36	276
19	Khurda	10	1355	42	1	-	-	41	1	19	22
20	Koraput	14	1915	857	430	-	-	427	216	216	425

Table-4 District wise details of un-electrified villages in the State contd.

S No	District	Blocks	Inhabited villages	Un-Electrified villages	In Hilly area	In forest area	On river side	In other areas	Within 3 Kms from the grid	Within 4-7 Kms from the grid	Beyond 7 Kms from the grid
21	Malkangiri	7	878	424	358	-	-	66	3	27	394
22	Mayurbhanj	26	3718	1182	35	308	-	839	9	44	1129
23	Nowrangour	10	880	270	-	-	-	187	-	5	182
21	Malkangiri	7	878	424	358	-	-	66	3	27	394
22	Mayurbhanj	26	3718	1182	35	308	-	839	9	44	1129
23	Nowrangour	10	880	270	-	-	-	187	-	5	182
24	Nayagarh	8	1511	456	113	196	-	147	171	173	112
25	Nuapara	5	643	187	-	-	-	187	-	5	182
26	Puri	11	1584	46	-	-	-	46	7	27	12
27	Rayagada	11	2445	1597	6	427	9	1155	299	655	633
28	Sambalpur	9	1247	384	-	371	-	13	136	201	47
29	Sonepur	6	808	136	-	127	-	9	93	31	12
30	Sundergarh	17	1688	128	-	127	-	1	6	28	94
	Total	**314**	**51048**	**11494**	**1463**	**2938**	**144**	**6949**	**2271**	**3570**	**5690**

Table-5 Status of village electrification

States/Uts	Total inhabitat villages (1991 census)	Villages electrified as on 31-03-2001 (Provisional)		Achievement During 2001-2002 (Provisional)			Total achievement to the end of May 2001	
		Numbers	Percentage	1-04-2001 to 30-04-2001	Month under Report	Cumulative at the end of May 2001		
Andhra Pradesh	26586	26565	100 0	-	-	-	26565	(*)
Arunachal Pradesh	3649	2206	60.5	NA	NA	NA	2206	(c)
Assam	24685	19019	77 0	NA	NA	NA	19019	(c)
Bihar	67513	35437	NA	NIL	NA	NIL	35437	($$) (d)
Jharkhand (++)		12488	NA				12488	
Goa	360	360	100 0	-	-	-	360	@
Gujarat	18028	17940	100 0	-	-	-	17940	(*)
Haryana	6759	6759	100 0	-	-	-	6759	
Himachal Pradesh	16997	16881	99 3	NIL	NIL	NIL	16881	
Jammu & Kashmir	6477	6315	97 5	NA	NA	NA	6315	($) (a)
Karnataka	27066	26702	98 7	NA	NA	NA	26702	(+) (b)
Kerala	1384	1384	100 0	-	-	-	1384	
Madhya Pradesh	51806	50286	97 1	NIL	NA	NIL	50286	
Chattisgarh	19720	18076	91 7	NIL	NA	NIL	18076	(d)
Maharashtra	40412	40412	100 0	-	-	-	40412	
Manipur	2182	2001	91 7	NIL	NIL	NIL	2001	
Meghalaya	5484	2518	45 9	NA	NA	NA	2518	(c)
Mizoram	698	691	99 0	NIL	NIL	NIL	691	
Nagaland	1216	1212	99 7	NIL	NIL	NIL	1212	(d)
Orissa	46989	35232	75 0	NIL	NA	NIL	35232	(d)
Punjab	12428	12428	100 0	-	-	-	12428	

Table-5 Status of village electrification contd

States/Uts	Total inhabitat villages (1991 census)	Villages electrified as on 31-03-2001 (Provisional)			Achievement During 2001-2002 (Provisional)		Total achievement to the end of May 2001	
Rajasthan	37889	35912	94 8	2	NIL	2	35914	
Sikkim	447	405	100 0	-	-	-	405	(#)
Tamil Nadu	15822	15822	100 0	-	-	-	15822	
Tripura	855	813	95 1	NIL	NIL	NIL	813	
Uttar Pradesh	97122	77047	79 3	NIL	1	1	77048	
Uttaranchal	15681	12488	79 6	NA	NA	NA	12488	(c)
West Bengal	37910	29596	78 1	7	NA	7	29603	(d)
Total (States)	6E+05	5E+05	86 5	9	1	10	507005	
Total (Uts)	1093	1090	100 0	-	-	-	1090	(*)
Total (All India)	6E+05	5E+05	86 5	9	1	10	508095	

Note: Target for the year 2001-02 not finalized

(*) Fully electrified. Balance not feasible for electrification

(#) Provisional. 42 Nos. forest villages not electrified

@ Provisional to be confirmed as per 1991 census.

(+) 329 villages declared non-feasible for electrification

(++) Separate data not available

($$) Achievement as per 1981 census.

($) Achievement as per 1971 census. 1991 census not held.

(a) As on 31.3.98

(b) As on 28.02.2001

(c) As on 31.03.2001

Table-6 Progress of Rural Electrification and Energization of Pump Sets in the State (in number)

Sl No	Item	Total	Electrified by the end of			
			8th Plan	1997-98	1998-99	1999-00
1	2	3	4	5	6	7
1	Inhabited villages	46,989	32,825 (69 86%)	33,625 (71 56%)	34,442 (73 30%)	35,190 (74 89)
2	Tribal villages	19,491	10,120 (51.92%)	10,296 (52 82%)	10,459 (53 66)	10,466 (53.70)
3	SC villages/Bastis	4,022 villages	3,762 (93 54%)	3,784 (94 08%)	3,784 (94 08%)	6,290 (include bastis)
4	Street lights in ST villages/bastis	-	30,380	30,380	30,380	
5	Street lights in SC villages/bastis	55,400	NA	11,575	11,679	12,580
6	Pump sets energised	-	70,113	72,047	73,359	74,526

Source. GRIDCO, Bhubaneswar

There are 19,491 tribal villages in the State out of which 10,466 have been electrified by the end of 1999-00 representing coverage of 53.70%. During the Ninth Plan, all the remaining tribal villages are proposed to be taken up for electrification.

Orissa Renewable Energy Development Agency (OREDA) functions as the state level nodal agency for promotion of various renewable energy systems OREDA has under taken the rural electrification of difficult and remote villages in the state through renewable sources like biomass, solar, micro hydel etc the achievements of the OREDA are shown in the table-7. OREDA has also taken up the survey of 23 blocks to assess the biomass potential. The summary of the eight blocks, which is shown in the table-8, are based on the resource availability based on these data the village electrification plans will be prepared.

Table-7 Achievement of Orissa Renewable Energy Development Agency

Sl No	Items	By the end of 1995-96	During the year			
			1996-97	1997-98	1998-99	1999-00
1	2	3	4	5	6	7
1	Bio-gas plants installed (National Project)	1,12,639	7,964	9,082	6,064	8,420
2	Community/ Institutional Bio-Gas plants installed	22	1	1	4	-
3	Improved chullah supplied/installed	11,13,378	1,00,0001	2,04,830	1,01,565	1,50,000
4	Solar photo-voltaic program -					
	(a) Community lighting system	3,342	-	52	-	-
	(b) SPV pumping system	102	-	-	-	-
	(c) SPV operated TV	102	-	-	-	-
	(d) SPV lanterns supplied	2,187	274	766	870	631
	(e) SPV street lighting System	1,375	68	305	3,000	184
	(f) Solar home lighting System	252	38	412	193	299
5	Solar thermal extension program -					
	(a) LPD of solar water heating system	95,630	40	3,500	5,200	5,200
	(b) LPD of solar distillation system	3,760	200	10	10	15
	(c) Solar cooker supplied	2,632	116	50	400	158

(d) P Provisional

(e) Source OREDA,Bhubaneswar

Table-8 Biomass potential

S No	Name of the Block	Total Biomass (MT)			Power Generation Potential (Mw)	Remarks
		Production	Consumption	Surplus		
1	Daspala	78021	58199	13621	2 17	Consumption of Biomass is mainly for fodder, fuel
2	Athamallik	60156	50140	10016	1 27	Thatching and manure
3	Pallahara	108003	94312	13691	6 57	
4	Bargarh	292283	165253	127030	2 5-3 0	
5	Dhenkanal	612251	474986	137265	15 0	
6	Aska	339191	295159	44032	13 0	
7	Koksara	67587	33405	34182	12 0	
8	Rajkanika	339191	295159	44032	7 0	
9	Jeypore	176130	95994	80136	29	
10	Malkangin	52965	21482	31483	9 0	
11	Udala	83507	73011	10496	0 5	
12	Brahamagin	187199	110650	76549	3 60	
13	Raygada	65317	53107	12210	0 98	

2.5 Weather data

The average weather data for the state of Orissa for the period from 1951 to1980 has been compiled by Indian Meteorological Department at Bhuvaneswar and cuttak following the guide lines of "Guide to Climatological Practices" published by the world meteorological organization (WMO N 100. TP. 44). The observing stations are classified into four classes according to WMO viz.

Principal Climatological Station, Ordinary Climatological Station, Precipitation Station and Climatological Station for Specific Purposes. The table-9 shows the four divisions and the pattern of data collection followed in each division. The state of Orissa is under II class i e Ordinary Climatological Station. On II class stations, the observations are made at fixed times, including readings of extreme temperature and amount of precipitation. Department nominates one person who collects the data also communicates at least two sets of observations daily The table-10 shows the Mean Monthly wind speed at synoptic hours, air temperature etc.

The meteorological elements observed are atmospheric pressure, dry bulb, wet bulb, maximum and minimum temperatures, humidity, amount of rainfall, direction and speed of wind, visibility, amount, form and direction of movement and height of base of clouds.

These observations are generally recorded at synoptic hours fixed internationally i.e. 0230, 0530, 0830, 1130, 1430, 1730, 2030, and 2330 hours I.S.T. corresponding to 00, 03, 06, 09, 12, 15, 18, and 21 hours universal time co-ordinate (U.T.C).

The Annuxre-5 shows Climatological table is for the period form 1951to1980. The Climatological Normal is arithmetic average of the climatological data computed for consecutive period of thirty years.

Table 9 Four divisions and the pattern of data collection

I M D classification of observatories (Surface and Hydrometeorological)	W M O classification of climatological stations
Class I	Principal Climatological stations
Class II, III & IV	Ordinary Climatological stations
Class V	Precipitation stations
Class VI	Climatological stations for specific purposes

Table 10 Mean values of solar radiation and associated parameters (computed)

Bhubaneshar

Mean daily radiation and sunshine

LAT 2 25 N LONG 85 87 E ELEV 26 MASL

PARAMETERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ETR	7 412	8 506	9 631	10 482	10 862	10 937	10 866	10 602	9 961	8 911	7.750	7 107
N	9 1	9 6	9 3	9 3	9 3	5 8	4 5	4 8	5 8	7 5	8 7	9 4
N*	10 14	10 63	11 19	11 75	12 20	12 42	12 33	11 96	11 44	10.86	10 32	10 02
I(H)	3 913	4 530	4 587	4 678	4.614	2 597	2 011	2 152	2 587	3 336	3 763	3 993
D	1 304	1 478	1 922	2 227	2 403	3 036	3 079	2 991	2 724	2 142	1 515	1 134
G	5 217	6 008	6 509	6 905	7 018	5 634	5 090	5 143	5 310	5 478	5 278	5.128
G(C)	5 421	6.328	7 588	7 723	7 860	7 700	7 663	7 538	7 119	6 382	5 594	5 128
C I	0 704	0 706	0 676	0 659	0 646	0 515	0 468	0 485	0 533	0 615	0 681	0 722
WS	81 9	85 3	89 2	93 6	97 2	99 1	98 3	95 3	91 2	86 9	83 1	81 0
CLEAR SKY NOON RADIATION												
I	0 860	0 848	0 845	0 808	0 777	0 755	0 754	0 774	0 796	0 814	0 844	0 868
I(H)	0 648	0 713	0 782	0 794	0 777	0 754	0 753	0 769	0 761	0 715	0 662	0 633
D	0 133	0 154	0 162	0 187	0 198	0 193	0 189	0 177	0 161	0 143	0 130	0 115
G	0 781	0 867	0 944	0 981	0 975	0 947	0 943	0 946	0 922	0 858	0 792	0 749
W	2 04	2 38	2 77	3 26	3 79	5 11	5 52	5 54	5 35	4 84	3 01	2 27
P	1009	1007	004	1000	995	991	989	994	999	1000	1007	1009

Units and Symbols

ETR -Extra-terrestrial solar radiation on a horizontal surface during one day, $kWh.m^{-2}.day^{-1}$

D -Diffuse solar radiation on a horizontal surface at any instant or for a whole day, $kW.m^{-2}$ or $kWh.m^{-2}.day^{-1}$

G -Global solar radiation on a horizontal surface at any instant oa during a whole day, kW.m-2 or $kWh.m^{-2}.day^{-1}$

G(c) - Global solar radiation on a horizontal surface for one day under mean clear sky conditions, $kWh.m^{-2}.day^{-1}$

N -Maximum possible hours of sunshine during a day counted from sunrise to sunset

N* -Maximum possible hours of sunshine during a day with solar elevation equal to or greater than 5 degrees

I (H) -Direct solar radiation on a horizontal surface at any instant or for a whole day, $kW.m^{-2}$ or $kWh.m^{-2}.day^{-1}$

C.I -Clearness index

WS-Sunset hour angle, degrees.

W -Hour angle of the sun, degrees.

P -atmospheric pressure at station level, millibars

I - Direct solar radiation normal to the solar beam reaching the ground at any instant or for a whole day,kW m^{-2} or kWh $m^{-2}.day^{-1}$

Table 10 contd

Mean monthly wind speed at synoptic hours - Bhubaneswar (airport)

Lat 20`15'N Long 85`50`E Elev 46 m a s l

Hours (IST)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0530	4 1	5 8	10 6	17 4	19 2	11 8	10 5	8 0	6 7	4 6	4 2	4 3
0830	5 0	5 4	8 2	14 1	16 4	9 7	8 7	6 0	6 5	5 8	5 4	5 4
1130	6 6	7 2	11 6	16 7	20 1	13 4	12 4	10 3	9 7	7 4	7 5	7 2
1430	9 4	10 2	13 6	16 8	19 9	14 8	16 2	12 8	12.8	10 0	10 2	10 4
1730	9 2	14 8	20 0	27 1	27 7	19 7	16 6	13 6	10 8	7.2	5 7	5 9
2330	5 2	8 1	13 7	20 0	20 6	14 5	11 9	9 2	7 5	5 0	3 9	4 1
24 hours	8 0	10 1	15 1	21 9	23 7	17 2	14 8	12 1	10 6	7 9	6.8	

Mean hourly total rainfall (mm)

Let 20'15' N, Long 85'50'E Elev 46 m a n l

	Hours (I S T) ending at											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12
JAN	0 5	0 3	1 0	5 6	0 1	0 8	1 4	1 1	0 5	0 7	2 5	2 5
FEB	0 2	0 4	0 2	0 0	0 0	0 0	0 0	0 0	0 3	0 1	0 1	0 0
MAR	0 1	0 1	0 0	0 0	0 3	0 1	0 6	0 5	1 0	0 9	0 3	0 0
APR	0 0	0 3	0 9	0 7	0 0	0 0	0 0	0 0	0 0	0.0	0 0	0 6
MAY	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
JUN	9 4	1 4	1 6	0 6	5 8	1 7	1 9	3 3	0 3	17 0	6 9	6 4
JUL	13 5	9 1	5 0	12 8	16 8	10 6	16 3	9 8	5 0	13 4	11 5	14 1
AUG	4 8	5 8	6 7	7 5	4 9	7 2	8 2	8 0	8 2	7 1	8 1	12 0
SEP	11 5	17 9	16 6	9 6	4 3	3 6	5 8	15 0	9 3	8 8	12 0	12 7
OCT	5 4	1 4	2 6	1 9	6 2	3 6	6 2	6 3	7 7	8 7	20.1	7 6
NOV	0 5	0 3	0 9	1 5	1 4	1 3	0 3	0 2	0 8	3 6	0 6	4 0
DEC	0 0	0 0	0 0	0 0	1 5	0 0	0 0	0 0	0 0	0 0	0 0	0 0

Table 10 contd.

MONTH	Hours (I S T) ending at 13	14	15	16	17	18	19	20	21	22	23	24
JAN	1 4	3 1	1 0	0 3	0 4	1 8	0 1	0 0	1 2	0 0	1 5	2 5
FEB	0 0	0 0	0 0	0 5	3 7	0 9	0 7	3 4	0 7	0 0	0 4	1 0
MAR	1 4	1 2	2 0	2 7	2 1	3 4	0 6	0 4	0 3	0 3	0 0	0 5
APR	0 0	0 0	0 0	3 0	3 3	1 0	0 4	8 1	4 3	1 3	5 6	0 5
MAY	0 0	0 0	2 3	6 4	1 5	0 9	5 1	0 3	0 9	0 4	0 9	0 1
JUN	10 4	8 4	24 2	22 2	10 4	5 8	7 6	5 5	6 7	3 7	7 2	3 5
JUL	13 8	7.3	20 5	22 7	24 0	19 7	15 5	13 2	9 1	6 2	8 8	5 6
AUG	20 5	16 0	25 2	34 1	14 9	18 7	8 3	10 0	3 4	4 4	7 6	5 7
SEP	14 1	20 0	23 8	17 5	22 4	9 5	31 9	9 6	9 2	10 0	4 6	3 3
OCT	5 6	4 5	8 0	22 9	6 4	14 6	7 7	2 4	3 3	10 4	7 5	4 3
NOV	0 3	3 2	1 7	3 4	1 7	2 4	1 6	1 9	4 1	0 6	0 1	0 6
DEC	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0

Based on data from 1964-1968

Mean hourly relative humidity (%)

Let. 20'15' N, Long 85'50'E Elev 46 m a n l

MONTH	Hours (I S T) ending at 1	2	3	4	5	6	7	8	9	10	11	12
JAN	87	88	89	89	89	89	89	84	79	61	54	50
FEB	88	88	89	89	90	89	88	78	66	57	48	41
MAR	87	88	88	89	89	90	88	80	66	54	46	38
APR	83	84	85	85	85	86	84	75	61	55	48	43
MAY	82	82	83	84	85	85	85	73	63	54	48	43

Table 10 contd

Let. 20'15' N, Long 85'50'E Elev 46 m a n l

	Hours (I S T) ending at											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12
JUN	85	86	86	86	87	87	89	79	72	65	60	56
JUL	92	92	92	92	92	93	92	89	83	80	76	75
AUG	91	92	92	92	92	93	91	90	85	82	79	77
SEP	92	93	93	93	93	93	93	90	85	76	77	76
OCT	92	92	92	93	93	93	92	86	78	72	67	64
NOV	88	88	89	89	89	90	88	77	64	57	52	47
DEC	84	85	89	90	90	90	89	77	61	52	46	41
MONTH	13	14	15	16	17	18	19	20	21	22	23	24
JAN	46	45	44	44	48	58	67	73	78	80	84	86
FEB	37	34	32	37	47	59	69	76	80	82	84	86
MAR	35	33	34	39	46	57	68	74	77	81	82	85
APR	40	40	42	49	54	62	74	75	78	80	81	83
MAY	40	37	41	44	51	59	65	69	73	75	77	79
JUN	54	55	56	59	63	68	74	77	79	81	83	84
JUL	74	74	75	77	79	83	85	87	89	89	90	91
AUG	77	77	78	80	82	85	87	88	89	90	90	91
SEP	74	75	75	78	81	86	88	89	90	90	91	92
OCT	61	61	62	64	72	79	82	86	87	89	90	91
NOV	44	44	44	46	55	64	71	75	78	82	84	86
DEC	40	37	37	38	45	55	62	68	71	75	79	82

Based on data from 1964-1968

Table 10 contd

Mean hourly air temperature (°C)

Let 20'15' N, Long 85'50'E Elev 46 m a n l

	Hours (I S T) ending at											
MONTH	1	2	3	4	5	6	7	8	9	10	11	12
JAN	18 0	17 8	17 5	17 1	17 0	16 9	17 0	19 0	21 2	23 4	24 5	25 3
FEB	21 4	21 0	20 6	20 2	19 8	19 4	19 9	22 4	24 9	27 1	26 9	30 2
MAR	24 1	23 7	23 4	23 1	22 8	22 6	23 3	25 4	27 7	29 2	31 7	33 1
APR	26 4	26 2	26 0	25 8	25 5	25 6	26 7	28 3	30 5	32 6	34 0	35 4
MAY	28 3	28 1	27 9	27 7	27 6	27 8	29 0	30 5	23 5	34 3	35 5	36 6
JUN	27 9	27 8	27 7	27 6	27 5	27 7	28 5	29 8	31 2	32 0	33 3	34 1
JUL	26 5	26 4	26 4	26 3	26 1	26 3	26 9	27 7	28 6	29 4	30 0	30 3
AUG	26 6	26 6	26 4	26 3	26 1	26 4	26 9	27 5	28 5	29 3	29 9	30 2
SEP	26 4	26 2	26 0	25 9	25 8	25 8	26 5	27 7	28 4	29 5	30 0	30 5
OCT	24 4	24 1	23 8	23 6	23 3	32 7	24 6	26 5	27 8	29 0	29 8	30 3
NOV	21 0	20 5	20 1	19 9	19 7	19 6	20 8	23 4	25 5	27 0	28 2	28 8
DEC	17 3	17 0	16 6	16 3	16 1	15 9	16 5	19 5	22 3	23 7	25 3	26 4

	Hours (I S T) ending at											
MONTH	13	14	15	16	17	18	19	20	21	22	23	24
JAN	25 9	26 0	26 5	25 9	24 8	23 0	21 8	20 9	20 6	19 8	19 2	18 6
FEB	31 2	31 5	31 6	30 8	30 4	26 5	24 9	23 9	23 3	22 8	22 6	21 9
MAR	33 9	34 2	33 8	32 2	30 7	28 5	27 2	26 1	25 8	25 5	24 9	24 5
APR	36 1	36 3	35 4	33 8	31 9	30 1	29 1	28 0	27 8	27 4	27 1	27 0
MAY	37 3	37 6	36 9	35 3	33 7	31 7	30 6	29 9	29 5	29 1	28 8	28 6
JUN	34 6	34 4	34 0	32 9	31 9	30 7	29 9	29 3	29 0	28 6	28 4	28 2
JUL	30 5	30 5	30 1	29 6	28 8	28 2	27 7	27 3	27 2	27 0	26 9	26 7
AUG	30 4	30 3	30 1	29 3	28 8	28 1	27 7	27 5	27 3	27 1	27 0	26 8
SEP	30 6	30 3	29 9	29 4	28 8	28 1	27 5	27 2	27 0	26 9	26 7	26 5

Table 10 contd

MONTH	Hours (I S T) ending at 13	14	15	16	17	18	19	20	21	22	23	24
OCT	30 5	30 5	30 1	29 5	28 3	27 2	26 5	26 1	25 7	25 3	25 0	24 1
NOV	29 2	29 1	29 1	28 4	26 8	25 2	24 3	23 7	23 1	22 5	21 8	21 2
DEC	26 7	27 1	27 0	26 4	24 8	23 0	21 6	20 8	20 0	19 1	18 3	17 8

Based on data from 1964-1968

Mean monthly values of meteorological parameters

Cuttack

Lat 20° 15'N Long. 85° 50' E Elev 27 *m a s l*

Hours (IST)	PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0830	T	18 7	21 9	25 8	29 1	31 1	30 1	28 1	28 1	28 5	27 1	23 0	19 2
	H	81	77	74	71	71	75	85	85	84	80	75	76
	W	1 4	2 0	3 5	5 0	5 7	4 8	4 3	3 2	3 5	2 7	1 8	1 1
1730	T	25 6	29 5	32 0	33 3	34 4	32 4	29 1	29 3	29 4	29 1	27 7	25 5
	H	53	47	45	52	55	66	80	81	79	72	59	55
	W	1 5	3 5	7 3	10 3	9 7	7 0	4 8	3 9	2 8	2 5	1 1	1 0
	T_{max}	28 6	32 2	35 8	38 5	39 5	35 9	31 9	32 1	32 5	32 4	30 9	28 9
	T_{min}	15 7	18 5	22 2	25 0	27 0	26 7	25 7	25 8	25 6	23 7	19 3	15 8
24 hours	W	3 1	4 7	6 3	8 7	9 9	8 1	7 0	6 2	5 4	3 9	2 9	2 5
24 hours	R	22 9	26 7	20 4	43 1	67 9	177 0	377 8	312 2	262 8	127 0	18 6	1 1

3 Village survey and biomass assessment in selected unelectrified villages of Ganjam district

3.1 Selection of the region for the feasibility study

Orissa is a backward state in India. One of the indictors for the backwardness is the large number of unelectrified villages. Out of the 51048 inhabited villages in the state, 11494 are yet to be electrified

Orissa is a biomass rich state. With agriculture being the main economic activity — the state generates a substantial quantity of surplus agro-residue — consisting of rice straw, rice husk, stalks of pulses and oilseeds etc. Around 35% of the area of the state is under forest, which is other important source of biomass. In addition, the state has 810245 hectare of barren and uncultivated land, which has the potential to be developed, into a sustainable source of biomass supply.

The three important criteria for selecting region for conducting feasibility study were:

- Location of unelectrified village clusters;
- Surplus biomass availability;
- Presence of community based organisation to manage the proposed project.

The data on unelectrified villages was collected from OREDA and local electricity utility companies. It can be observed that all the 30 districts in the state have unelectrified villages. The information on biomass availability and forest cover was collected from OREDA and state forest department. Biomass availability studies conducted by OREDA indicate that most parts of the state have some amount of surplus biomass [table 11]. Thus almost all the districts fulfils the criteria of surplus biomass availability and unelectrified villages. Under these conditions, the sustainability of the intervention was used as the main criteria for selecting the region for the feasibility study. Past experience has shown that sustainability of any decentralized rural electrification project/ rural development projects depend to a large extent on the community initiative and involvement in the project and in its capability to manage such projects. Hence, presence of a credible community based organisation, which can guide and harness community initiatives into feasible and successful development projects becomes important. Gram Vikas, a leading Non government organisation based in Orissa has a long experience of working with poor rural communities in development projects in the area of housing and energy. Gram Vikas was identified as the local partner for carrying out the feasibility study, and the region surrounding the Gram Vikas head quarters located in district Ganjam was selected for the feasibility study.

Table 11 Satement showing the details of taluk-wise-surplus biomass available and capacity of power generation in Orissa as per taluk level biomass assessment studies conducted through consultants

Name of the state/District	Name of Taluka	Total Biomass production (tonnes)	Total biomass consimption (tonnes)	Surplus biomass (tonnes)
Orissa				
Nayagarh	Daspala	204880	159034	45846
Angul	Athamallik	60156	50140	10016
Angul	Pallahara	108003	94312	13691
Bargarh	Bargarh	292283	165253	127030
Dhenkanal	Dhenkanal	612251	474986	137265
Ganjam	Aska	339191	295159	44032
Kalahandi	Koksara	67587	33405	34182
Kendrapara	Rajkanika	339191	295159	44032
Koraput	Jeypore	176130	95994	80136
Malkangiri	Malkangiri	52965	21482	31483
Mayurbhanj	Udala	83507	73011	10496
Puri	Brahamagiri	187199	110650	76549
Raygada	Raygada	65317	53107	12210

3.2 Selection of unelectrified villages in Ganjam district

Kududakhandi and Digapahandi are the two blocks located adjacent to the Gram Vikas head quarters at village Mohuda in Ganjam district. A list of 30 non-electrified villages of Dighapandhi and 12 villages of Kukdakhani block in Ganjam district were collected from the OREDA, Bhubneshwar [table 12 and 13]. After discussion with Gram Vikas officials and field workers, eight villages from these lists were selected for the feasibility study.

Table 12 List of Un-electrified villages - Kududakhandi block, Ganjam district, Orissa

Village name	Village code	Distance from power line (km)
1 Buduka	16	10
2 Koilikoute	166	11
3 Betajhar	167	10
4 Bhaliyaguda	169	9
5 Chakundajhola	102	8 5
6 Ralpada	151	9
7 Baradhangidi	154	12 5
8 Karajai	155	13
9 Badasulia - Mitrapur	156	13
10 Sarokata	159	12
11 Madun - Ramadiha	168	7
12 Rampalli	24	6

3.3 Methodology for village survey

Village survey consisted of collection of data from both secondary as well as primary sources.

3.3.1 Secondary data

Data relating to demography, socio-economic and infrastructure profile of state and the district were collected from the Directorate of Census, Directorate of Economic & Statistics, OREDA. The village level information on population, land use pattern etc. were collected from the block office as well as from the Revenue Inspectors.

3.3.2 Primary data

Village and household schedules

To obtain the village level data a village questionnaire schedule was designed [Annexure 6] The schedule was designed to collect primary data on demography, infrastructure, amenities, livestock, energy consumption pattern, biomass availability, lighting requirement etc. The schedule was pre-tested and refined with the assistance of Gram Vikas team. The questionnaire was filled at the village by interacting with village elders. To collect household level information, sample households were surveyed in each village (Photo 6). A copy of the household schedule is enclosed as Annexure 7.

Assessment of woody biomass

The methodology for assessing sustainable woody biomass production consisted of:

a) Collecting information from the revenue inspector on the land use within village boundary.

b) Carrying out sample measurements.

The formulas used for calculating the sustainable yield are provided in Annexure 8.

Table 13 List of unelectrified villages in Digapahandi

S.No	Name of the village	Village code	Distance from power line (km)
1	Ghasiamda	194	10
2	Gochapata	137	10
3	Daduruma	196	8
4	Kuruma	197	7
5	Pitamahula	198	10
6	Palakhala	206	8
7	Khaspa	25	2
8	Gudankanda	89	4
9	Chandiagarada	90	4
10	Bhaliaguda	111	8
11	Talahaladiben	115	5
12	Kinchindu	118	6
13	Mahulapada	119	6
14	Khemanda	140	5
15	Mundiapatharu	149	8
16	Tada	150	8
17	Palikhadia	152	5
18	Sahadeba	1	5
19	Birapiatambarasasan	37	7
20	Olagulonda	42	10
21	Kamarkhali	44	10
22	Mahulapada	50	6
23	Gatiambagam	52	8
24	Gatikhandagam	53	8
25	Pipalapadar	55	8
26	Dekili	89	6
27	Arjunapur	92	7
28	Kirakai	36	9
29	Khanqudarajendthapur	73	10
30	Urhidapattarajendrapur	91	11

3.4 Results of the primary survey

3.4.1 *Profile of selected villages*

All the study villages [table 14] are located in hilly and forested area The inhabitants of these villages are tribals. The average family size is around 5 Majorities of the households posses agriculture land, rest are dependent on *jhum* cultivation. The climate is moist sub-humid, with annual temperature variations ranging from 15°C in winter to 45°C during the summer season

Table 14 Selected villages for feasibility study

Village	No of households	Distance from grid (km)	Distance from motorable road (km)
Koikoute	30	6	4
Betajhar	30	6	4
Mitrapur	27	8	6
Sarokata	34	8	7
Rampalli	35	4	2
Sankaranjai	20	12	8
Ramadiha	50	7	0
Chinyagarda	29	4	4

3.4.2 *Infrastructural facilities*

The literacy rate of the villages is very low, ranging from 10% among adults to 60% among children. Lack of schooling facilities in the proximity of the villages seems to be the main reason for the low literacy rate. Gram Vikas has started primary schools in five of the eight selected villages for the study. Villages are located 4 to 8 km away from the market and linked with *kachha* road. Generally kerosene depot is also situated in the market. Primary health center is also situated in the block which is quite far off from the villages. Some of the villages experience acute water shortage for drinking as well as for irrigation during summer months. Under Gram Vikas programmes, each village has a village level committee for the community development programme.

3.4.3 *Economy*

Agriculture is the primary occupation. With very limited irrigation facilities, agriculture is dependent on rains. Paddy and ragi are the principal crops. *Jhum* is practised in most of the villages. Millets and maize are cultivated in the *jhum* areas. Land holding size is generally small. Cutting wood from the forest and selling it in the nearby markets is the main source of income. All the adult family members are engaged in this activity. In a day they collect around 30 to 40 kg of wood, which is sold in the market next day. The selling price for 30-40 kg of wood ranges from Rs 15 to 20. In a month they earn Rs 600 to 1000 per family through this activity.

3.4.4 *Land use pattern*

Table 15 indicates that villages have substantial area which is either not available for cultivation or is cultivable wasteland. This is the area which is the main sources of woody biomass. The forest area is limited.

Table 15 Area under different types of land use (hectares)

Village	Forest land	Cultivable land	Cultivable waste land	Area not available for cultivation
Kolkoute	167.14	31 97	8.90	0
Betajhar	28.73	11.74	2.43	161.06
Mitrapur	1 12	10 93	0	312 82
Sarokata	10 12	28 73	2 02	246 86
Rampalli	38 45	130 71	7 28	19 43
Sankaranjai	31 16	2 43	6 03	312 82
Ramadiha	12 95	9 31	1.21	4.05
Chinyagarda	-	1.21	131.12	0 41

3.4.5 *Energy consumption*

Cooking is the dominant energy end-use. All the households meet their cooking energy needs through fuelwood in the form of logs, branches, twigs and shrubs. On an average, daily consumption of firewood in a typical household is 7 kg/day[1]. Kerosene is used for lighting, monthly consumption of kerosene is about 3.3 litters/family for lighting. The details of energy consumption are given in table 16.

Table 16 Fuel consumption in the selected villages

Village	Cooking Wood - ton /year	Lighting Kerosene -litres/year
Koikoute	79	1440
Betajhar	77	1080
Mitrapur	78	972
Sarokata	87	1306
Rampalli	89	1680
Sankaranjai	58	672
Ramadiha	110	2400
Chinyagarda	64	1044

[source primary survey]

3.4 6 Status of biomass resources

Inhabitants of these villages have strong linkages with their surrounding natural environment to fulfil their basic requirements as well as to earn for their livelihood (Photo 1 & 2). The sources of biomass comprises of forests, *jhum* land (under cultivation and fallow) cultivation land, pasture land and homestead.

Common tree species found are *Acacia arabica, Cassia ciamea, Leucaena leucocephala, Albizia lebbek, Glyricidia sepium* and weed species including shrubs i.e. *Lantana camera, crotolaria spe., and Zizyphos rotundifolia.* The common grass species are *Sorghum halepense, Imparata cylindrica and Saccharum spontaneum.*

Table 17 Total available biomass in different land categories (tons)

Village	Forest land		Cultivable waste land		Area not available for cultivation	
	Tree	Shrub	Tree	Shrub	Tree	Shrub
Koikoute	1119 84	133.71	59 63	10 32	0	0
Betajhar	192.49	22.98	16 28	2 81	1079 1	185 21
Mitrapur	7 50	0 89	0	0	2095 89	359.74
Sarokata	67 80	8 06	13 53	2 34	1653 96	283 89
Rampalli	257 61	30.76	48.77	8 44	130 18	22 34
Sankaranjai	208 77	24 93	40.40	6 99	20 95	359 74
Ramadiha	86.76	10 36	8.10	1 4	27 13	4.65
Chinyagarda	0	0	878 50	152 1	2 74	0 41

The sustainable yield for different land categories is shown in table 18.

Table 18 Sustainable biomass availability in the study villages (tons/year)

Village	Tree biomass	Shrub biomass	Total biomass	Consumption	Surplus biomass
Koikoute	78 63	48 01	126.64	78 84	47 80
Betajhar	85.85	70 34	156 19	76 65	79.54
Mitrapur	140 22	120 21	260 44	78 84	181.60
Sarokata	115 68	98 11	213 79	86 87	126 92
Rampalli	29.10	20 51	49 62	89 42	-39.80
Sankaranjai	156 33	130.55	286 89	58 4	228.49
Ramadiha	8 13	5.47	13 60	109.5	-95.89
Chinyagarda	58 75	50 85	109 60	63.51	46 09

3.4.7 Biomass cost

The availability of surplus biomass and the opportunity to buy the same exists throughout the year in the study villages. At present, the villagers are selling firewood in the market @ Rs 0.5 per kg (Photo 3 & 4). During discussions they indicated that they would be willing to sell firewood @ Rs 0.3 to 0.35 per kg for a biomass gasifier plant installed in their village.

Table 19 Landed cost of biomass at the plant site

Biomass	Present cost at market Rs/kg	Cost at village site Rs/kg	Bulk order Rs/kg for gasifier in the village
Tree	0.50	0.40	0.35
Shrub	0.50	0.35	0.30

3.4.8 *Willingness to pay for electricity*

The villagers were also asked about the possible uses of the electricity and the rates at which they would be willing to pay for the electricity. The information gathered is compiled in table 20.

Table 20 Willingness to pay for electricity

Village	Households	Price that the villagers are willing to pay for electricity for lighting	Price that the villagers are willing to pay for electricity for other applications
Koikoute	30	Rs 15/month for single light point for electric supply 6 hrs/ day	Irrigation - Rs 200/ month
Betajhar	30	Rs 15-20/month for single light point for electric supply 6 hrs/ day	Irrigation - price not disclosed
Mitrapur	27	Rs 15-20/month for single light point for electric supply 6 hrs/ day	Leaf plate making Flourmill - Price not disclosed
Sarokata	34	Rs 20/month for single light point for electric supply 6 hrs/ day	Flourmill - price not disclosed
Rampalli	35	Rs 20/month for single light point for electric supply 6 hrs/ day	Irrigation- Rs 160-170/ month
Sankaranjai	20	Rs 15/month for single light point for electric supply 6 hrs/ day	-
Ramadiha	50	Rates fixed by the Government	-
Chinyagarda	29	Rs 15-20/month for single light point for electric supply 6 hrs/ day	Irrigation Rs 200/ month

3.4.9 *Estimation of electric load requirement*

Based on the discussion, maximum electricity requirement for each household was calculated as follows.

Lighting: 3 bulbs each of 60 W (immediate requirement) = 180 W
Fan, T V etc. (possible future requirements) = 150 W
Total **330 W**

The calculated electricity requirement for each village is presented in table 21.

Table 21 Electricity requirement

Village	Households	Connected load - Household lighting (kW) @ 0.33 kW/household	Connected load - Street lighting/ lighting of common areas (kW)	Connected load -pumping/ industrial application(kW)	Total connected load (kW)
Koikoute	30	9.9	2.0	5	17
Betajhar	30	9.9	2.0	Nil	12
Mitrapur	27	8.9	2.0	5	16
Sarokata	34	11.2	2.0	5	18
Rampalli	35	11.6	2.0	Nil	14
Sankaranjai	20	6.6	2.0	Nil	9
Ramadiha	50	16.5	2.0	Nil	19
Chinyagarda *	29 + 40 =69	22.8	2.0	5	30

* 40 families from a nearby village are expected to be shifted to Chinyagarda in near future

The total electricity load requirement for these surveyed villages vary between 10 to 30 kW. The villages are compact and hence distribution of electricity would require less investment and would be easy to maintain (Photo 5).

3.4.10 *Ranking of the villages for the demonstration project*

TERI and Gram Vikas teams jointly decided on the rankings of the villages for any future biomass gasifier based electrification project. The rankings are based on:

1. Biomass availability. Following factors where considered while ranking villages on biomass availability:
   - Type of biomass
   - Cost of biomass
   - Area for biomass generation

2. Load development possibilities. Due to low plant utilisation factor and low revenue inflows, a village electrification project based only on lighting is generally not feasible. Therefore, it is essential to develop loads in addition to lighting. Further more if these applications results in income generation activities, the scope for enhancing revenue collection from the electrification scheme improves. The feasibility for following additional loads were checked in each village:
    - Irrigation pumping
    - Rice mill
    - Leaf plate making
    - Drinking water supply
3. Presence of Gram Vikas in the village as well as range of the activities
    - Years of association
    - Range of activity
    - Future plan.

This criterion provided an indicator of the capability of the village level institution for taking up village electrification project.

4. Accessibility. Accessibility was considered important for the demonstration project. Distance from the nearest motorable road as well as Gram Vikas head quarters were taken into consideration while ranking the villages on accessibility.

Table 22 Ranking of villages

Village	Biomass availability	Load development possibilities	Presence and range of GV activities	Rank
Koikoute	Good	Limited	Long term presence	III
Betajhar	Good	Limited	Limited presence	IV
Mitrapur	Good	Good	Long term presence	II
Sarokata	Good	Good	Long term presence	I
Rampalli	Less	Limited	Limited presence	V
Sankaranjal	Good	Limited	Limited presence	III
Ramadiha	Low	Good	Limited presence	V
Chinyagarda	Medium	Good	Long term presence, extensive coverage	III

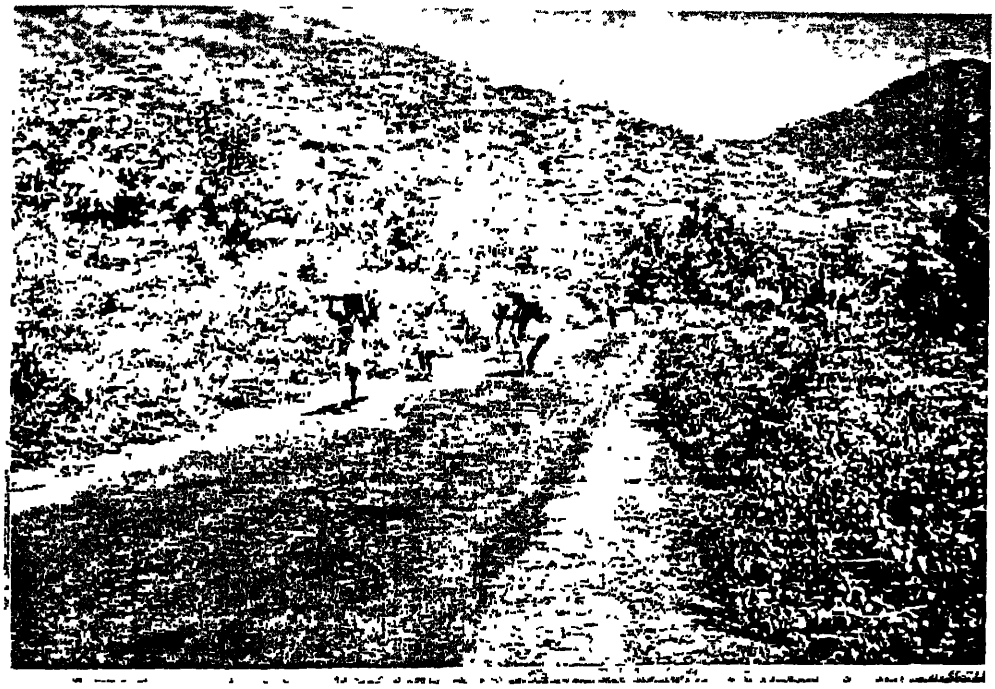


Photo 1 &2. Villagers carrying firewood collected from the nearby forest/common areas. The collected firewood is for own consumption as well as for selling in the market. Typical landscape of the area including trees and shrubs can be seen in the background.

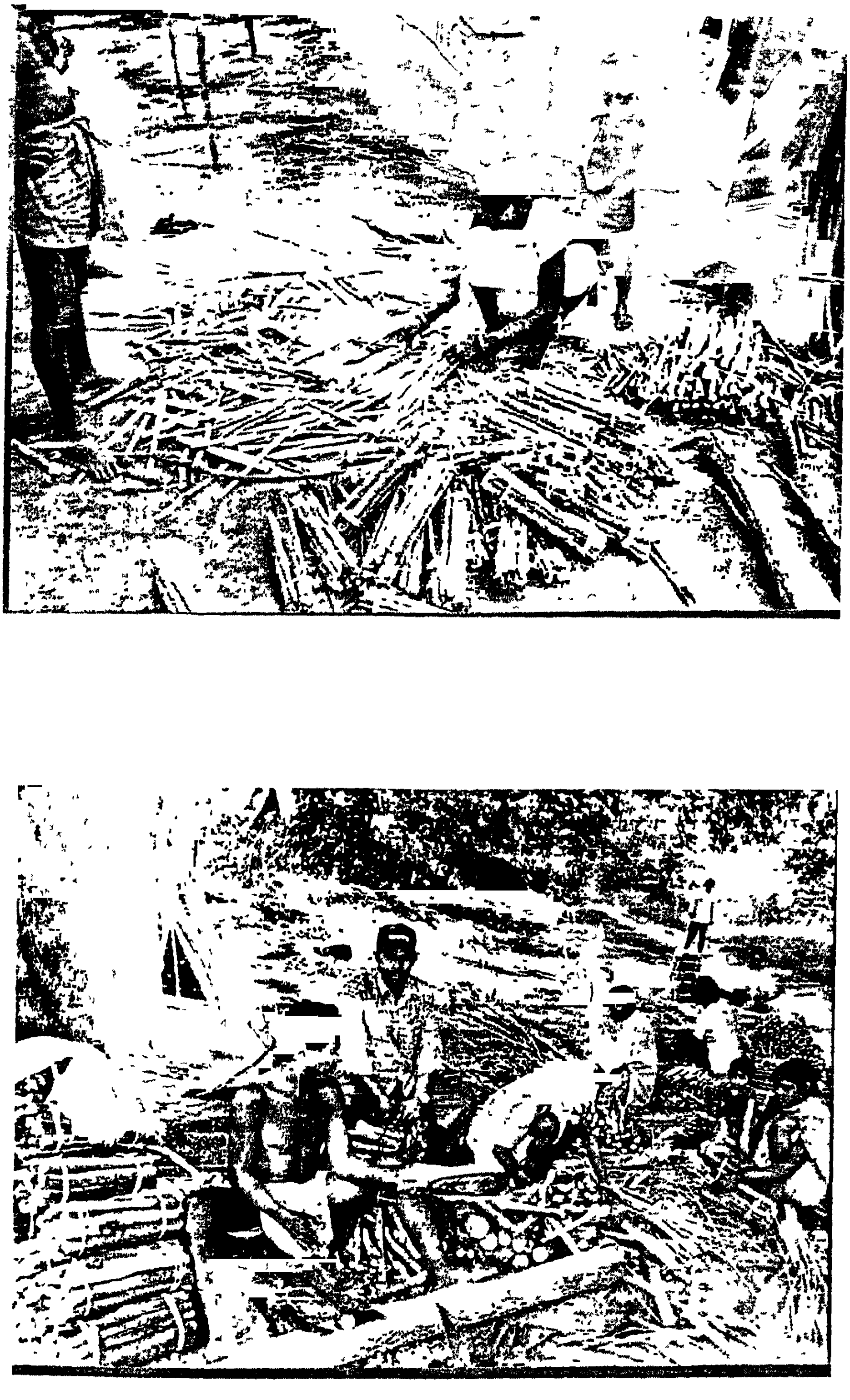


Photo 3 & 4. Villagers processing firewood for selling it in the local market. Long and thick wood pieces are cut into small pieces and tied in small bundles. The weight of one bundle is around 4 -5 kg and the selling price is Rs 2.

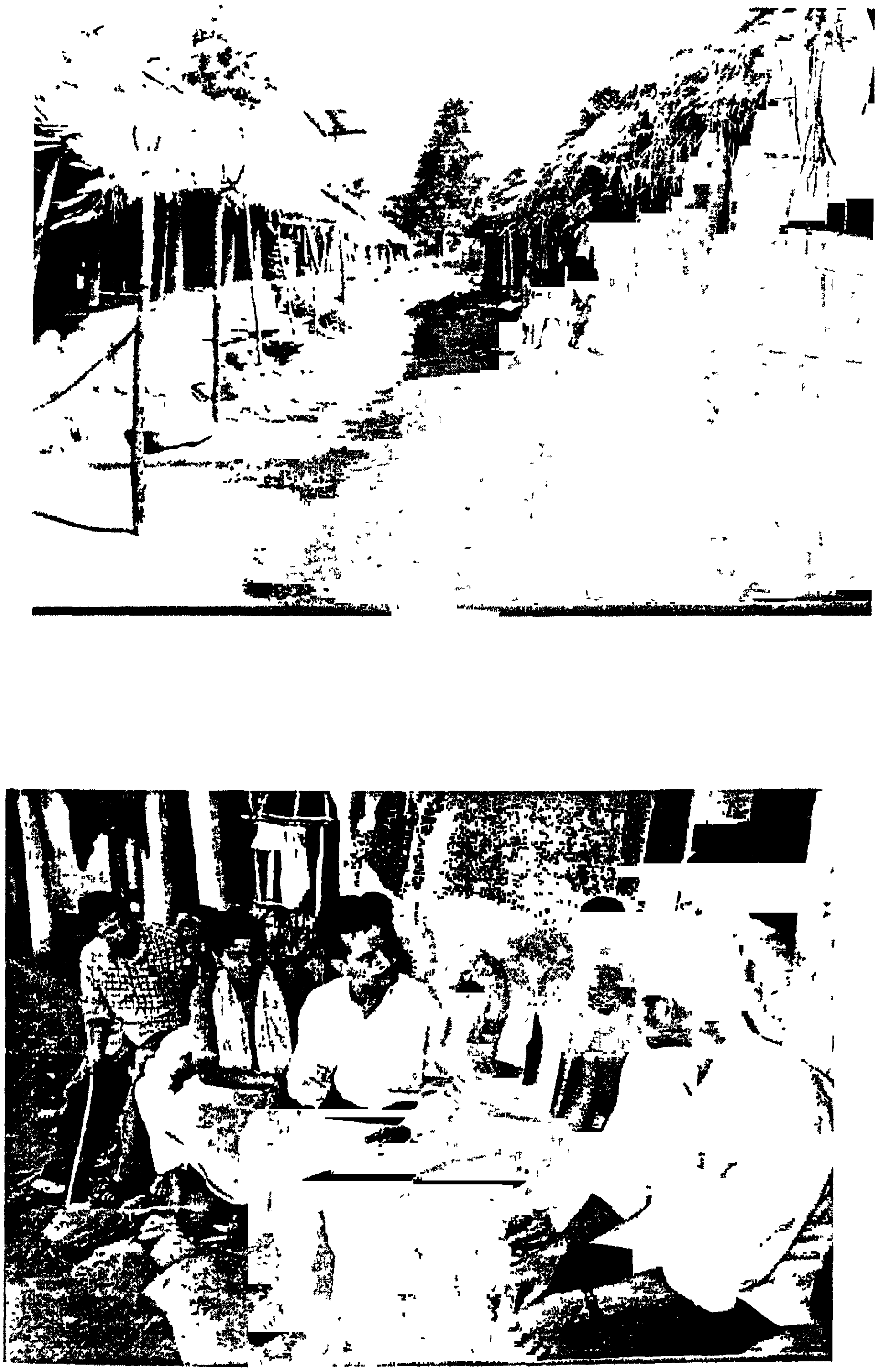


Photo 5 & 6 Typical village in the study area. The village is very compact, with houses located in two rows facing each other. In the second photograph, villagers are being surveyed for the feasibility study

4 Financial viability of gasifier based village electrification system

In this chapter the financial feasibility of a biomass based gasifier based power plant with a commercial outlook has been studied. For this purpose, about 10 non-electrified villages in state of Orissa were surveyed and the important operating factors and individual cost and revenue items are considered for analysis.

Background to the Analysis

There are a few important costs have been adopted in this analysis which were obtained from the survey. These are as follows:

Raw material

As discussed in the earlier chapter except two villages all other villages have surplus biomass availability of the order of more than 100 tonne/year. The biomass requirement for running the 15-kWe output would be of the order of about 30 ton/year.

Raw material collection and processing

(1) In almost all the surveyed villages fuel wood selling is the main occupation and the same fuel wood will be available for this plant. The biomass will be made to size in the mechanical cutter supplied along with the system. Other biomass in the form of shrubs/weed is also available in plenty and can be utilized depending on requirement. The collection and transport of these materials will be carried out manually. For the purpose of our analysis, the cost of biomass is inclusive of costs of collection, transportation and pre-processing.

Working Year for System

(2) The system will operate 365 days in a year. Based on the survey it is proposed to run the system for about 4 hours a day for providing lighting purpose through out the year. In addition to lighting needs of the village, the plant will operate for 3 hours a day (in daytime) for about 150 days in

a year for irrigation purpose. The plant will store sufficient biomass required for monsoon month before the start of monsoon.

Cost Increases

(3) The rates of increase which have been taken into account for the different elements of cost are as follows:

	Item	Annual cost increase (%)
1.	Electricity price	6%
2.	Raw Material Cost	4%
3.	Manpower	6%
4.	Repairs & maintenance	6%

These increases have been derived judgementally using expected inflation rates.

Interest rates

(4) The rate of interest charged normally by financial institutions amounts to around 12% per annum. However, for the purpose of setting up a rural electrification system a concessional rate of finance is expected to be available from MNES/ IREDA and the rate of interest for the same is 8.5%. We have used this rate of interest for the purpose of our analysis.

Details Relating to Size of Unit and Initial Investment

(5) The capacity of the system is estimated considering the future load requirement of household. At the first year of operation, the plant will supply two light points per household each of 60 W capacity which will increase to three points in subsequent year. In addition to household lighting street lighting at common places in the villages are also planned. It is also assumed that in subsequent year the load of fan and TV will also get added Keeping this load into consideration the plant size is estimated.

Output of each unit

(6) The plant would operate for two times a day, from 6 to 10 in the evening for domestic lighting and about 3 hour in the morning for irrigation purpose. The plant would operate all 365 days for lighting purpose and about 150 days in a year during summer for irrigation purpose. On this basis, the load in first year of operation would come to (34*0.12*4*365) +(6*3*150) kWh or 8657 kWh. It is expected that domestic load would increase to 200 W, 260 W and 330W per house hold in second third and fourth year of operation. T he plant repairs and maintenance would be carried out in the day time and hence no shut down is expected during normal operation of the system.

Plant & Machinery and other Infrastructure

(7) The unit is estimated to be 15 kWe output with reference to infrastructure and plant and machinery, as given below

Gasifier based Power Plant for 15 kWe output:

Land	Village community
Biomass gasifier	150000
Cooling and cleaning system	150000
Instrumentation	50000
Gas engine generators, and ancillary equipment including plant foundations	350000
Biomass cutter	15000
Local grid and distribution system	126000
TOTAL CAPITAL ASSETS IN USE	841000

Capital Structure

(8) Under the rural electrification program of Government of India, 90% capital subsidy is proposed for these plants. The balance 10% is expected to be mobilized through the village panchayat fund. Complete capital finance of the system will be done through internal sources and no bank loan is expected for these plants.

Table1: Basis for deriving different elements of operating statement

ITEM	DETAILS	AMOUNT (Rs '000)
OPERATING STATEMENT		
Sales	Net sales price is taken as Rs 20/ month/ HH/point for domestic lighting and Rs 35/h for 150 days for irrigation purpose in the first year. The price of electricity tariff is assumed to rise by 6% annually	Rs (50*20*34* 12 1300) + (Rs (35*3*150) = Rs 32070
Raw material consumption	The specific biomass consumption per unit of electricity produced is about 1 4 kg/kWh and the cost of processed biomass required for gasifier operation is taken Rs 0 4 /kg for the first year The price of raw material price will assumed to rise by 4% annually	
Direct Labour	One trained operator @ Rs 1000 per month to overlooks all operations of the plant. Direct labour costs are assumed to rise at 6% per annum	Rs 1000 per month
Repair & maintenance	In our analysis, we have assumed that the main operator will do the daily maintenance of the system The schedule repair and maintenance of gas engine will be carried out by the authorized service centre of the engine and about Rs 1000 per month is kept for repair and maintenance of the plant. Repair and maintenance costs are assumed to rise by 6% annually	Rs 12000 per annum

The operating and cash flow statements of unit are shown in Table. The cost of the project and means of financing has been shown in Table 1. The basis for arriving at the net sales and the different elements of cost are shown in Table. During the 15 years life cycle period of the system the unit generate about 6.3 lakh with out adjusting the depreciation of the system.

Summary of Cash flow & income statement

Period in years	1	2	3	4	5
A Net Revenue by sale of electricity for cash & credit (in Rs)					
Domestic or residential					
Lights and fans	16320	28543 7	39424 9	51509 1	54599 6
Heating and small power					
Commercial					
Lights and fans					
Heating and small power					
Industrial					
Low and medium voltage					
High voltage					
Public lighting					
Public water works					
Irrigation	15750	16695	17696 7	18758 5	19884 0
TOTAL REVENUES BY SALE OF ELECTRICITY	32070	45238 7	57121 6	70267 6	74483 6
B Miscellaneous Revenue from consumers					
Installation charges	34000				
Rentals from meters					
TOTAL MISCELLANEOUS REVENUE FROM CONSUMERS	34000				
SUMMARY OF INCOME AND CASH FLOW STATEMENT					
Net electricity generation (kWh)					
Electricity generation for lighting	5956 8	9828 7	12807.1	15785 5	15785 5
Electricity generation for Irrigation	2700	2700	2700	2700	2700
Total electricity generation	8656 8	12528 7	15507 1	18485.5	18485 5
STATEMENT OF OPERATING EXPENSES FOR THE GASIFIER BASED POWER GENERATION SYSTEM					
A BIO-MASS GASIFIER BASED POWER GENERATION					
a)Operation					
Fuel (Fire wood)	4848	7297	9393	11644	12110
Lubricants and other consumables stores					
Water (if purchased separately)					
Miscellaneous expenses					
Salaries of operator and other staff	12000	12720	13483	14292	15150
TOTAL OPERATION	16848	20017	22876	25937	27260
(b)Maintenance					
Biomass gasifier					
Cooling and cleaning systems					
Gas engines, generators and ancillary equipment including plant foundations	12000	12480	12979	13498	14038
Miscellaneous power plant and equipment					
TOTAL MAINTENANCE	12000	12480	12979	13498	14038
(C)Depreciation					
Depreciation on Biomass gasifier based power generating plant and Equipment	67280	67280	67280	67280	67280
TOTAL POWER GENERATION EXPENSES	96128	99777	103135	106715	108578

ANNUXERE-1 State's Socio-economic indicators

S No	Parameter	Indicator
1	Percentage distribution of area	4 7
2	Percentage distribution of population, 1991 census	3 7
3	Percentage of urban population to total, 1991 census	13 38
4	Population density (per sq km of area) 1991 census	203
5	Percentage of literacy, 1991 census	49 1
6	Percentage of SC population 1991	16 20
7	Percentage of ST population 1991	22.21
8	Percentage of total workers to total population 1991	37 5
9	Population density (per sq km of area) 1991 census	32 8
10	Percentage of forest area to total area 1996-97	37 3
11	Percentage of net Area shown to total reported area 1996-97	38.3
12	Percentage of net area irrigated to net area shown 1996-97	35 0
13	Consumption of fertilizer per unit gross cropped area 1999-00 (kg/hect)	40 6
14	Yield rate of rice 1998-99 (qtl /hect)	12 1
15	Yield rate of food grains 1998-99 (qtl /hect)	10 8
16	Percentage share of food grains production to all India 1998-99	2 85
17	Percentage of villages electrified upto March'1999	73
18	Per capita consumption of electricity in kWh 1997-98	446 7
19	Population per bank (in'000) as on March 2000	16 3
20	Credit/ deposit ratio as on March 2000	39 8
21	Estimated annual birth rate per 1000 population 1998	25 7
22	Estimated annual death rate per 1000 live birth 1998	11 1
23	Estimated annual infant mortality rate 1998	98
24	Length of road per 1,000 sq mm of area 1996-97 (in Km)	1687
25	Railway route length per 1,000 sq km of area 1998-99 (in Km)	15 03
26	Railway route length per lakh population 1998-99 (in Km)	6 63
27	Registered motor vehicles per 1000 persons 1997-98	22 21
28	Vehicle density per sq km 1997-98	4 98
29	Percentage of villages connected with all weather roads 95-96	40
30	No. of post offices per lakh of population 1998-99	23
31	Percentage distribution of factory workers to total all India factory workers 1997-98	1.79
32	Per capita gross output in industry 1997-98 (in Rs.)	4231 2
33	Per capita value added by manufacture 1997-98 (in Rs)	1065.7
34	Per capita total revenue of State including resources transferred from Center 1999-00 (in Rs)	1714 9

Annexure I contd

35	Per capita own revenue (tax and non-tax) 1999-00 (in Rs.)	822 4
36	Per capita own tax revenue 1999-00 (in Rs)	577 5
37	Per capita State budgetary expenditure 1999-00 (both revenue & capital account (in Rs)	2850 9
38	Per capita State Govt. expenditure on medical, public health & family welfare, 1999-00 (in Rs)	136.3
39	Per capita State Govt expenditure on education, sports, art & culture 1999-00 (in Rs)	438 9
40	Per capita milk production 1995-96 (in kg.)	18 3
41	Percentage of population below poverty line 1993-94 (Rural)	49 7
42	Percentage of population below poverty line 1993-94 (urban)	41.6
43	Percentage of population below poverty line 1993-94 (combined)	48 6
44	Per capita Net State Domestic Product 1998-99 (Q) - All current prices (in Rs)	8719
45	Per capita Net State Domestic Product 1998-99 (Q) - At constant (1993-94) prices (in Rs.)	5648

ANNUXERE-2 Land utilization pattern in Orissa

Sl No	Year	Geographical area	Forest Area	Misc tree	Perm-anent pastures	Cultu-rable waste	Land put to non-agn use	Barren & unculturable land	Current fallow	Other fallow	Net area shown
1	2	3	4	5	6	7	8	9	10	11	12
1	1989-90	15571	5476	859	726	514	742	499	177	254	6321
2	1990-91	15571	5476	859	726	597	746	499	150	214	6304
3	1991-92	15571	5482	855	726	572	748	499	168	184	6337
4	1992-93	15571	5478	857	663	538	781	532	215	203	6304
5	1993-94	15571	5534	867	635	487	781	541	180	243	6303
6	1994-95	15571	5722	715	514	435	858	553	197	298	6279
7	1995-96	15571	5722	715	514	435	858	553	241	323	6210
8	1996-97	15571	5606	764	534	445	858	570	483	343	5968
9	1997-98	15571	5606	774	534	445	866	590	298	336	6122
10	1998-99	15571	5606	774	534	445	866	590	372	336	6048

Source Directorate of Agriculture and Food Production, Orissa, Bhubaneswar

Annexure-3 Cropping pattern of principal crops in Orissa (Area in hectare)

Sl No	Crops	1992-93		1993-94		1994-95	
		Area	% to total	Area	% to total	Area	% to total
1	2	3	4	5	6	7	8
(A)	Cereals						
1	Rice	44,432	70.90	45,553	71 32	44,557	70 77
2	Wheat	60	0 10	39	0 06	49	0.08
3	Maize	669	1 07	609	0 95	468	0 74
4	Ragi	799	1 27	852	1 33	809	1 29
5	Others	971	1 55	975	1.53	932	1 48
	Total (A)	46931	74.89	48028	75.2	46815	74.36
(B)	Pulses						
6	Gram	311	0.50	308	0 48	348	0 55
7	Arhar	1653	2.64	1,667	2.61	1,661	2 64
8	Other pulses	7026	11 21	7,095	11 10	7,330	11 64
	Total (B)	8990	14.35	9,070	14 20	9,339	14 83
	Total food grains (A+B)	55921	89.24	87098	89 4	56154	89 19
(C)	Oil seeds						
9	Groundnut	1120	1.79	1001	1 57	873	1.39
10	Sesamum	841	1 34	-	-	720	1 14
11	Rape seed and mustard	259	0 41	337	0 53	298	0 47
12	Caster seeds	252	0 40	256	0 40	264	0 42
13	Others	2341	3 74	3301	5 17	2519	4 00
	Total (C)	4813	7 68	4895	7 66	4674	7 42
(D)	Fibers						
14	Cotton	53	0 08	35	0 55	66	0 10
15	Jute	89	0 14	38	0 06	74	0 12
16	Other fibers	331	0 53	404	0.63	472	0 75
	Total (D)	473	0.75	477	0.75	612	0.97
(E)	Other crops						
17	Sugarcane	160	0 26	134	0 21	203	0 33
18	Tobacco	149	0 24	100	0 16	103	0.13
19	Potato	109	0 17	104	0 16	97	0.15
20	Chillies	945	1.51	963	1.51	1000	1 59
21	Ginger	97	0 15	96	0 15	114	0 18
	Total (E)	1460	2.33	1397	2.19	1517	2.42
	Grand Total (A+B+C+D+E)	62667	100.00	63867	100.00	62,957	100.00

Annexure 3 contd

Sl No	Crops	1995-96		1996-97		1997-98		1998-99		1999-00 (P)	
		Area	% to total	Area	% to total	Area	% to total	Area	% to total	Area	% to total
1	2	9	10	11	12	13	14	15	16	17	18
(A)	Cereals										
1	Rice	45,290	71 79	44,672	75.76	44,973	74.68	44,467	74 89	46,018	77 22
2	Wheat	49	0 08	50	0 08	61	0 10	39	0 06	59	0.10
3	Maize	441	0.70	583	0 99	528	0 88	509	0 86	544	0 91
4	Ragi	715	1 13	814	1 38	798	1 32	810	1 36	818	1.37
5	Others	832	1.32	784	1 33	615	1 02	580	0 78	510	0 85
	Total (A)	47,327	75 02	46,903	79.54	46,975	78 00	46,405	78.15	47,949	80.45
(B)	Pulses										
6	Gram	382	0.61	291	0 49	326	54 00	320	0 54	320	0.54
7	Arhar	1,665	2 64	1,233	2 09	1,466	2 44	1,390	2 34	1,360	2.28
8	Other pulses	6,923	10 97	4,739	8 34	5,523	9 17	5,340	8 99	4,679	7 85
	Total (B)	8,970	14 22	5,263	10.62	7,315	12.15	7,050	11 87	6,359	10.67
	Total Food-grains (A+B)	56,297	89.24	53,166	90.16	54,290	90 15	53,455	90.02	54,308	91.12
(C	Oil seeds)										
9	Groundnut	911	1 45	966	1.64	854	1 42	836	1.40	701	1.17
10	Sesamum	634	1.00	776	1.31	720	1 19	536	0 90	529	0.89
11	Rape seed and mustard	230	0 36	194	0.33	199	0 33	190	0.31	171	0 29
12	Caster seeds	289	0.46	194	0 33	NA	-	200	0.33	190	0 32
13	Others	2,514	3 98	1,932	3 27	2,452	4 07	2,079	3 50	1,610	2 70
	Total (C)	4,578	7.25	4,062	6.88	4,225	7.01	3,881	6 54	3,201	5.37
(D)	Fjbers										
14	Cotton	109	0 17	157	0 27	218	0.36	290	0 49	380	0 64
15	Jute	84	0.14	120	0 20	92	0 15	53	0 09	41	0 07
16	Other fibers	454	0 72	452	0 77	436	0.72	360	0 60	340	0 57
	Total (D)	647	1.03	729	1.24	746	1.24	703	1.18	761	1.28
(E)	Other Crops										
17	Sugarcane	273	0 43	235	0 40	187	0.31	224	0.38	207	0.35
18	Tobacco	91	0.14	93	0 16	86	0.14	-	-	-	-
19	Potato	89	0 14	101	0 17	89	0 15	80	0.13	87	0.14

Annexure 3 contd

Sl. No	Crops	1995-96		1996-97		1997-98		1998-99		1999-00 (P)	
		Area	% to total	Area	% to total	Area	% to total	Area	% to total	Area	% to total
Sl. No	Crops	1995-96		1996-97		1997-98		1998-99		1999-00 (P)	
		Area	% to total	Area	% to total	Area	% to total	Area	% to total	Area	% to total
20	Chilies	995	1 58	490	0 83	498	0.83	901	1 52	910	
21	Ginger	117	0 19	93	0 16	102	0 17	135	0 23	123	
	Total (E)	1,565	2.48	1,012	1 72	962	1 60	1,340	2 26	1,327	
	Grand Total (A+B+C+D+E)	63,087	100.00	58,969	100 00	60,223	100 00	59,379	100 00	59,597	

P: Provisional

Source: Directorate of Agriculture and Food Production, Orissa, Bhubaneswar, Directorate of Economics and Statistics, Orissa, Bhubaneswar

ANNUXERE-4 Yield rate of Principal Crops in Orissa

Sl No	Crops	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
1	2	3	4	5	6	7	8	9
1	Rice (total)	14 53	14 26	13 75	9 93	13 79	12 12	11.27
(i)	Autumn rice	9 00	9 86	9 51	5 46	9 83	6 12	9 32
(ii)	Winter rice	15 48	14 94	14 22	10 01	14 38	13 05	10 32
(iii)	Summer rice	21 09	19.41	31 88	22.67	19 24	18 89	23 89
2	Ragi	6 42	5 90	6.12	6 02	5 89	6 40	6 47
3	Gram	5 82	5 71	6.68	6 37	5 45	5 94	5 00
4	Mung	2 44	2 58	2.88	2.00	2 02	2.02	2.04
5	Biri	3 65	3.54	3 01	2.64	3 12	2 75	2.63
6	Sugarcane	582 84	589 87	583.90	566.41	612 14	656.62	579 31
7	Mustard	1.88	1.95	1.69	1.47	1.61	1 25	1 53
8	Jute	12 69	11.33	15.49	16.02	13 37	14.10	17.18
9	Cotton	1 54	2.45	2.00	3.27	2 84	2 93	3.53
10	Potato	112.51	111.74	96 95	115 75	98 20	116.50	104.25
11	Groundnut	11 39	11 22	10 00	8 17	10 77	8.61	10 70

P· Provisional

Source: Directorate of Agriculture and Food Production, Orissa, Bhubaneswar.

Directorate of Economics and Statistics, Orissa, Bhubaneswar

Annexure-5 Climatological Table

CLIMATOLOGICAL TABLE

Station Angul

Month	Mean				Humidity		Cloud Amount			Rainfall			No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min °C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	1 2	3 5	6 7	8	0	1 2	3-5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	17 8	15 3	27 4	13 9	75 0	15 5	1 9	0 9	12 1	61 7	0 0	4 8	20	2	3	2	4	26	1	1	0	2	1	0 7	1 9	4 1	14 9	9 4
Feb	20 8	17 4	30 9	16 8	70 0	17 1	2 2	1 5	33 1	370 1	0 0	5 8	16	2	3	2	5	22	1	1	1	3	0	0 5	1 7	3 8	12 8	9 2
Mar	24 9	20 5	35 4	20 2	66 0	20 4	2 2	1 4	22 9	110 0	0 0	6 6	19	2	3	3	4	24	1	2	1	3	0	0 1	1 7	6 5	12 9	9 8
Apr	29 0	23 9	39 0	24 0	64 0	25 6	2 2	1 1	28 3	130 8	0 0	8 1	16	3	5	2	4	24	1	2	1	2	0	0 0	1 2	5 2	12 5	11 1
May	30 9	25 7	40 2	26 2	65 0	28 9	2 8	1 4	43 7	190 2	0 0	9 6	15	3	6	2	5	23	2	3	1	2	0	0 0	1 0	5 2	11 4	13 4
June	29 6	25 8	36 4	25 9	73 0	30 0	6 0	4 1	200 0	497 1	39 4	9 3	2	2	5	5	16	12	2	4	2	10	0	0 0	1 4	8 0	8 6	12 0
Jul	27 6	25 2	31 8	24 6	82 0	30 3	7 0	5 5	292 9	552 5	111 2	8 2	0	1	4	5	21	6	3	5	2	15	0	0 0	2 5	10 6	5 0	12 9
Aug	27 4	25 2	31 3	24 3	83 0	30 4	7 1	5 6	307 6	826 0	96 5	7 2	1	1	3	5	21	5	3	6	3	14	0	0 1	2 5	9 4	7 2	11 8
Sep	27 3	25 2	31 7	24 0	83 0	30 2	6 2	4 7	214 7	569 7	56 1	6 3	1	2	6	5	16	6	4	7	3	10	0	0 1	1 9	8 1	7 0	12 9
Oct	25 8	23 4	31 2	21 9	80 0	26 8	4 4	3 1	107 9	404 5	0 5	5 5	8	3	5	5	10	14	3	5	3	6	0	0 1	1 3	7 7	9 7	12 2
Nov	21 8	18 8	29 1	16 9	74 0	19 5	2 4	1 3	15 8	161 5	0 0	4 5	16	3	4	3	4	22	2	2	1	3	0	0 2	1 1	4 8	13 6	10 3
Dec	18 0	15 3	27 1	13 8	73 0	15 3	1 7	0 6	2 6	36 6	0 0	5 0	20	3	3	2	3	29	0	1	0	1	0	0 1	0 7	4 9	14 7	10 6
Annual total or mean	25 1	21 8	32 6	21 0	74 0	24 2	3 8	2 6	1287 0	2148 5	756 1	6 7	134	27	50	41	113	213	23	39	18	71	1	1 9	18 9	78 3	130 3	135 6
Number of Years	30 0	30 0	30 0	29 0	30 0	29 0	30 0	23 0	30 0	75 0	75 0	21 0			28						28					28 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Balasore

Month	Mean				Humidity		Cloud Amount			Rainfall			No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min oC	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3-5	6-7	8	0	T 2	3-5	6 7	8	FOG 8	Upto 1 Km	1-4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	18 6	15 1	27 1	13 9	67 0	14 5	1 9	0 6	8 4	120 9	0 0	5 8	18	5	3	4	1	26	2	1	1	1	0	0 1	3 5	8 0	12 1	7 3
Feb	21 8	17 5	30 0	16 8	64 0	16 6	2 2	1 2	29 6	251 7	0 0	7 5	16	3	4	4	1	21	2	2	2	1	0	0 3	2 5	7 6	7 2	10 4
Mar	26 5	21 6	33 9	21 0	64 0	21 9	2 3	1 1	35 0	153 7	0 0	11 0	15	5	5	5	2	21	4	4	2	0	0	0 1	2 1	9 4	10 4	9 0
Apr	29 7	25 1	36 5	24 4	68 0	28 0	3 0	1 4	52 3	194 3	0 0	14 3	10	6	6	7	1	19	3	4	3	0	0	0 0	1 4	8 7	8 1	11 8
May	30 9	26 7	36 5	26 0	71 0	31 6	4 1	2 1	102 7	436 4	11 5	13 2	6	5	7	10	3	13	6	7	4	1	0	0 0	1 8	8 6	7 9	12 7
June	29 9	26 8	34 4	26 1	78 0	32 8	6 4	3 4	222 9	673 9	30 7	10 0	2	1	4	15	8	7	5	9	7	2	0	0 0	1 7	9 3	6 1	12 9
Jul	28 4	26 4	31 7	25 6	85 0	32 7	7 1	4 2	290 5	786 4	82 3	9 7	0	0	2	17	12	3	7	11	7	3	0	0 0	1 9	8 7	5 8	14 6
Aug	28 4	26 5	31 5	25 7	85 0	32 9	7 1	4 0	349 1	836 4	89 1	8 2	1	1	2	15	12	5	6	10	7	3	0	0 0	1 9	9 0	4 3	15 8
Sep	28 4	26 2	31 6	25 3	84 0	32 0	6 3	3 2	321 9	856 2	59 9	6 2	0	2	5	15	8	6	8	9	5	2	0	0 0	2 1	7 9	5 2	14 8
Oct	27 1	24 4	31 2	23 1	79 0	28 3	4 2	1 8	216 0	633 5	0 0	4 7	7	5	6	9	4	13	8	5	3	2	0	0 0	1 2	10 5	4 7	14 6
Nov	23 0	19 4	29 4	17 9	70 0	19 7	2 4	0 6	32 1	265 7	0 0	3 9	12	6	5	5	2	25	3	1	0	1	0	0 0	0 4	8 7	6 6	14 3
Dec	18 9	15 3	27 2	14 0	67 0	14 6	1 8	0 3	7 0	113 0	0 0	3 7	17	5	4	4	1	29	1	1	0	0	0	0 0	2 7	10 0	10 0	8 3
Annual total or mean	26 0	22 6	31 8	21 7	74 0	25 5	4 1	2 0	1689 3	2957 1	1075 9	8 2	103	44	53	110	55	188	56	64	41	16	0	0 5	23 2	106 4	88 4	146 5
Number of Years	26 0	26 0	26 0	26 0	26 0	26 0	26 0	19 0	26 0	91 0	91 0	26 0			24						24					24 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Sonepur

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb oC	Wet Bulb oC	Daily Max oC	Daily Min oC	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T-2	3 5	6 7	8	0	T-2	3 5	6-7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	19 5	16 4	27 8	13 8	71 0	16 5			7 0	30 1	0 0	2 5												0 4	2 6	4 5	10 5	13 0
Feb	22 5	18 5	31 4	16 7	67 0	18 1			14 6	111 6	0 0	3 3												0 1	2 6	4 4	11 5	9 4
Mar	26 7	20 6	35 5	20 8	56 0	19 4			18 8	119 2	0 0	4 0												0 4	3 8	5 2	13 3	8 3
Apr	31 9	24 2	39 4	25 9	51 0	23 7			13 2	52 2	0 0	5 7												0 2	4 3	3 3	11 9	10 3
May	33 8	26 0	41 5	28 7	53 0	27 4			26 4	106 7	0 0	6 7												0 0	12 0	4 0	15 5	10 3
June	30 9	25 9	36 6	26 9	68 0	29 0			189 5	530 1	42 3	8 4												0 2	2 3	5 1	14 7	7 7
Jul	27 8	25 4	31 3	24 8	79 0	30 5			423 4	780 6	200 0	7 4												0 6	3 4	7 6	14 3	5 1
Aug	27 6	25 7	30 9	25 0	81 0	31 3			383 5	741 4	72 6	7 5												1 3	2 2	5 2	12 2	10 1
Sep	28 2	25 8	31 8	24 8	79 0	31 1			262 2	475 7	68 8	5 7												0 1	1 1	4 9	13 3	10 6
Oct	26 9	24 1	31 5	23 3	76 0	27 9			69 9	216 7	0 0	3 6												0 0	1 5	4 9	13 1	11 5
Nov	23 1	20 0	29 4	17 6	71 0	21 1			2 8	24 1	0 0	2 4												1 3	4 0	5 1	10 5	9 1
Dec	19 4	16 4	27 0	12 8	69 0	16 3			1 7	11 9	0 0	2 0												0 2	7 0	4 6	8 6	10 6
Annual total or mean	26 5	22 4	32 8	21 8	68 0	24 4			1413 0	2187 9	980 2	4 9												4 8	36 0	58 8	149 4	116 0
Number of Years	24 0	24 0	23 0	22 0	25 0	24 0			22 0	22 0	22 0	20 0														13 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Banpada

Month	Mean				Humidity		Cloud Amount			Rainfall			No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min °C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T 2	3 5	6-7	8	FOG 8	Upto 1 Km	1-4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	17 7	14 4	27 5	12 5	68 0	13 8	1 7	0 8	14 6	86 4	0 0	1 5	19	4	4	3	1	23	4	3	1	0	0	0 3	4 6	10 3	15 8	0 0
Feb	20 8	16 5	30 7	15 5	63 0	15 5	1 5	0 8	26 9	137 6	0 0	2 1	16	5	3	2	2	22	3	2	1	0	0	0 2	2 7	6 8	18 3	0 0
Mar	26 1	20 4	35 6	20 2	58 0	19 6	1 5	0 9	37 9	120 8	0 0	3 0	18	6	4	2	1	23	4	3	1	0	0	0 2	5 7	9 3	15 1	0 7
Apr	29 8	24 4	38 9	24 2	64 0	26 4	2 0	1 2	49 5	135 4	0 5	3 8	13	7	6	3	1	19	5	5	1	0	0	0 8	5 6	6 9	15 6	1 1
May	31 2	26 5	39 1	25 9	68 0	30 8	2 7	1 5	101 7	255 8	15 4	4 3	9	8	7	5	2	17	6	6	2	0	0	0 0	2 5	10 0	17 6	0 9
June	30 1	26 9	35 8	26 1	78 0	32 9	5 6	3 1	256 0	554 4	70 0	3 1	1	4	7	10	8	6	7	10	5	2	0	0 0	3 7	8 6	15 6	2 1
Jul	28 5	26 5	32 3	25 5	85 0	32 9	6 5	3 8	321 0	506 7	94 2	2 1	0	1	7	12	11	3	6	13	6	3	0	0 0	4 3	10 6	14 9	1 2
Aug	28 2	26 4	32 1	25 2	86 0	32 9	6 4	3 9	436 0	966 1	99 1	1 8	0	1	7	12	11	5	6	11	7	2	0	0 0	3 2	10 9	15 5	1 4
Sep	28 3	26 1	32 3	24 7	83 0	32 0	5 2	3 2	327 3	645 6	117 6	1 6	1	5	8	9	7	6	9	9	4	2	0	0 1	3 7	9 1	16 3	0 8
Oct	26 6	23 7	32 1	22 4	77 0	27 1	3 3	1 9	181 3	667 4	5 1	1 4	8	8	6	5	4	12	9	6	3	1	0	0 0	2 7	6 9	19 9	1 5
Nov	22 5	18 9	29 9	17 1	69 0	19 0	2 0	1 0	14 4	69 5	0 0	1 3	14	7	4	3	2	21	5	3	1	0	0	0 1	2 5	4 7	21 3	1 4
Dec	18 4	14 9	27 4	12 7	67 0	14 3	1 4	0 5	4 2	31 2	0 0	1 4	18	6	4	2	1	25	3	2	1	0	0	0 1	2 2	11 2	16 5	1 0
Annual total or mean	25 7	22 1	32 8	21 0	72 0	24 8	3 3	1 9	1770 8	2659 3	1191 0	2 3	117	62	67	68	51	182	67	73	33	10	0	1 8	43 4	105 3	202 4	12 1
Number of Years	26 0	26 0	26 0	24 0	26 0	26 0	26 0	23 0	25 0	25 0	25 0	26 0			25						25					25 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Bhawani Patna

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount oktas					No days with visibility					
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	1 2	3 5	6 7	8	0	1 2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	20 9	16 0	29 2	12 5	60 0	14 5	1 0	0 8	3 4	20 4	0 0		23	3	3	1	1	23	5	3	0	0	0	0 0	0 0	0 6	1 3	29 1
Feb	24 5	18 4	32 7	17 1	55 0	17 3	1 4	0 8	11 5	48 7	0 0		18	4	4	1	1	18	7	3	0	0	0	0 1	0 2	0 5	1 9	25 3
Mar	29 3	21 0	37 5	21 0	45 0	18 2	0 8	0 5	6 3	21 6	0 0		24	3	4	0	0	24	6	1	0	0	0	0 0	0 1	0 3	0 7	29 9
Apr	32 3	23 0	40 5	26 1	44 0	20 9	1 7	0 9	10 4	27 1	0 0		18	5	5	1	1	19	8	3	0	0	0	0 1	0 1	0 2	1 7	27 9
May	33 6	24 3	41 3	27 4	46 0	23 0	2 2	1 2	25 0	71 4	0 0		16	4	7	1	3	18	9	4	0	0	0	0 0	0 2	0 2	2 9	27 7
June	30 6	25 1	36 6	26 0	65 0	27 3	4 5	2 3	241 7	572 9	107 8		9	2	7	3	9	9	7	14	0	0	0	0 3	1 5	2 2	6 5	19 5
Jul	27 5	24 6	31 2	24 3	80 0	28 7	6 0	3 1	331 7	557 4	127 3		3	0	8	5	15	3	7	21	0	0	0	0 5	2 7	2 8	12 4	12 6
Aug	27 0	24 5	30 8	24 0	81 0	28 8	6 5	3 3	283 0	436 9	184 8		4	0	6	4	17	5	6	20	0	0	0	0 2	2 4	3 0	14 9	10 5
Sep	27 8	24 8	31 8	23 7	78 0	28 9	4 7	2 4	170 0	470 5	53 7		5	2	10	4	9	6	11	13	0	0	0	0 0	1 7	1 7	7 2	19 4
Oct	26 8	23 1	31 7	21 3	73 0	25 4	3 1	1 6	70 1	228 5	0 0		14	4	6	2	5	14	9	8	0	0	0	0 2	0 3	0 5	3 7	26 3
Nov	23 5	19 5	29 9	17 0	67 0	19 3	2 2	1 2	29 9	89 3	0 0		15	5	5	2	3	17	7	6	0	0	0	0 1	0 2	0 4	3 3	26 0
Dec	20 0	15 9	27 9	12 7	65 0	15 2	1 4	0 7	0 3	44 9	0 0		20	5	3	2	1	24	5	2	0	0	0	0 0	0 8	0 8	1 6	27 8
Annual total or mean	27 0	21 7	33 4	21 1	63 0	22 3	3 0	1 6	1272 3	1616 7	1272 3		169	27	68	26	65	180	87	98	0	0	0	1 5	10 2	13 2	58 1	282 0
Number of Years	13 0	13 0	13 0	13 0	13 0	13 0	13 0	13 0	12 0	12 0	12 0				12						12					12 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Bhubaneshwar (A)

Month	Mean				Humidity		Cloud Amount			Rainfall			No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T-2	3-5	6 7	8	FOG 8	Upto 1 Km	1-4 Kms	4 10 Kms	10 20 Kms	Over 20
Jan	20 4	17 2	28 3	15 5	71 0	17 2	1 9	0 7	12 4	87 6	0 0	8 1	15	6	5	4	1	25	3	2	1	0	0	0 7	2 6	19 4	7 6	0 7
Feb	23 2	19 7	31 5	18 5	71 0	20 2	2 3	1 3	24 2	126 7	0 0	10 3	12	6	5	4	1	18	5	4	1	0	0	0 6	1 3	15 4	9 6	1 1
Mar	26 7	23 0	34 9	22 2	72 0	25 0	2 6	1 6	24 2	81 9	0 0	15 3	11	7	6	6	1	16	7	5	3	0	0	0 1	0 6	14 6	14 3	1 4
Apr	29 7	25 4	37 3	25 2	70 0	28 8	3 4	1 9	21 8	84 7	0 0	22 3	6	7	9	7	1	14	6	7	3	0	0	0 0	0 1	10 4	16 0	3 5
May	31 2	26 6	37 9	26 6	69 0	31 4	4 3	2 5	55 5	149 7	0 0	23 4	3	5	11	9	3	9	7	10	4	1	0	0 0	0 1	9 7	16 5	4 7
June	30 0	26 5	35 4	26 2	76 0	32 0	6 1	2 8	196 4	499 3	51 0	17 3	0	2	6	14	8	6	8	12	4	0	0	0 0	0 8	11 6	12 5	5 1
Jul	28 1	26 1	31 7	25 2	85 0	32 2	6 9	3 4	325 3	552 2	179 2	14 6	0	0	4	14	13	3	7	16	5	0	0	0 0	0 6	12 9	13 3	4 2
Aug	28 0	26 1	31 4	25 1	85 0	32 4	6 7	3 3	329 5	481 6	110 5	12 7	0	1	4	15	11	4	7	15	5	0	0	0 0	0 9	11 5	14 0	4 6
Sep	28 2	26 1	31 7	24 8	84 0	32 1	5 9	3 0	287 6	729 0	108 9	10 7	1	2	7	13	7	5	8	13	4	0	0	0 1	0 7	9 3	15 5	4 4
Oct	27 2	24 5	31 4	23 0	80 0	28 7	4 1	2 0	208 0	586 9	27 5	8 5	5	6	8	9	3	10	9	9	3	0	0	0 0	0 5	10 0	16 2	4 3
Nov	24 2	20 5	29 8	18 7	70 0	21 2	2 6	0 7	37 4	184 0	0 0	8 0	9	8	6	5	2	22	5	2	1	0	0	0 0	0 5	13 9	13 2	2 4
Dec	20 9	17 0	28 0	15 3	66 0	16 4	1 8	0 3	5 5	64 7	0 0	7 2	16	7	4	3	1	28	2	1	0	0	0	0 1	0 8	17 3	11 1	1 7
Annual total or mean	26 5	23 2	32 4	22 2	75 0	26 5	4 1	2 0	1542 2	2270 9	1068 4	13 2	78	57	75	103	52	160	74	96	34	1	0	1 6	9 5	156 0	159 8	38 1
Number of Years	29 0	29 0	29 0	29 0	29 0	29 0	29 0	24 0	30 0	30 0	30 0	29 0			28						28					28 0		

Anexure 5 contd

CLIMATOLOGICAL TABLE

Station Sambalpur

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T-2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	18 8	15 1	27 5	12 4	66 0	14 4	1 2	0 6	10 9	149 3	0 0	2 5	21	3	4	2	1	27	2	2	0	0	0	1 0	4 8	8 7	12 8	3 7
Feb	22 0	16 9	30 6	15 0	58 0	15 3	1 1	0 5	16 8	168 6	0 0	3 6	20	3	3	1	1	24	2	2	0	0	0	1 1	3 3	5 9	13 7	4 0
Mar	26 2	19 4	39 8	18 7	50 0	16 9	1 4	0 8	24 0	152 4	0 0	4 2	21	3	4	2	1	25	3	3	0	0	0	1 1	3 7	7 1	15 4	3 7
Apr	31 1	22 5	39 4	23 5	45 0	20 0	1 5	0 6	7 7	89 4	0 0	5 0	18	5	5	2	0	25	3	2	0	0	0	1 5	3 4	4 5	15 3	5 3
May	33 3	24 7	41 6	26 9	48 0	24 2	1 8	0 6	16 1	133 6	0 0	6 6	16	6	5	3	1	25	4	2	0	0	0	0 0	1 5	5 2	17 0	7 3
June	30 7	25 4	37 3	26 5	66 0	28 4	4 5	2 6	204 9	821 7	29 0	7 4	5	3	9	7	6	10	6	10	2	2	0	0 0	2 6	6 6	14 7	6 1
Jul	27 4	25 3	31 3	24 8	83 0	30 3	6 0	4 0	449 5	1065 8	185 7	7 1	1	3	7	10	10	3	6	12	5	5	0	1 0	5 0	7 7	12 9	4 4
Aug	27 3	25 3	31 1	24 6	85 0	30 7	6 0	4 2	458 9	910 1	120 7	6 4	1	2	8	10	10	2	5	14	4	6	0	1 0	5 3	7 8	12 3	4 6
Sep	27 9	25 5	31 9	24 4	82 0	30 7	4 8	2 7	256 0	814 5	32 8	5 0	3	4	10	9	4	6	8	11	3	2	0	0 2	2 8	7 6	14 5	4 9
Oct	26 9	23 6	31 6	21 8	75 0	26 7	2 8	1 5	62 6	277 9	0 0	3 3	11	5	8	5	2	16	6	6	2	1	0	0 1	2 4	6 6	15 3	6 6
Nov	23 0	19 2	29 5	16 2	69 0	19 3	1 5	0 6	4 8	158 5	0 0	2 8	17	5	5	2	1	24	3	3	0	0	0	0 8	3 2	7 6	13 6	4 8
Dec	19 3	15 6	27 4	12 1	67 0	14 9	1 1	0 5	3 0	65 8	0 0	2 4	21	4	4	2	0	27	2	2	0	0	0	1 4	3 6	8 7	14 6	2 7
Annual total or mean	26 2	21 5	32 8	20 6	66 0	22 7	2 8	1 6	1530 7	2712 0	930 4	4 7	155	46	72	55	37	214	50	69	16	16	0	9 2	41 6	84 0	172 1	58 1
Number of Years	30 0	30 0	30 0	30 0	30 0	30 0	30 0	24 0	29 0	99 0	99 0	27 0			29						29					29 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Puri

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min °C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T-2	3-5	6-7	8	0	T-2	3 5	6-7	8	FOG 8	Upto 1 Km	1-4 Kms	4 10 Kms	10-20 Kms	Over 20 Km
Jan	21 4	18 3	27 0	17 4	73 0	18 8	1 9	0 5	12 8	165 3	0 0	11 6	15	6	6	3	1	27	2	1	1	0	0	0 2	0 3	19 3	1 4	9 8
Feb	24 6	21 5	28 5	20 6	75 0	23 2	2 5	0 9	13 9	119 6	0 0	15 1	11	7	6	3	1	19	3	5	1	0	0	0 0	0 1	18 4	1 4	8 1
Mar	27 5	24 4	30 4	24 1	78 0	28 5	2 9	0 9	11 6	115 6	0 0	19 7	11	6	8	4	2	21	4	5	1	0	0	0 0	0 1	20 0	1 9	9 0
Apr	28 7	26 5	31 0	26 2	83 0	32 9	3 5	1 2	12 1	107 9	0 0	22 9	6	7	9	6	2	17	6	6	1	0	0	0 0	0 0	18 3	2 2	9 5
May	30 0	27 8	32 1	27 3	84 0	35 6	4 3	1 6	29 4	531 6	0 0	23 8	4	5	11	7	4	14	7	8	1	1	0	0 0	0 1	17 8	3 4	9 7
June	29 8	27 7	32 1	27 0	84 0	35 5	5 8	2 0	161 2	571 0	23 4	22 2	4	1	7	10	8	14	4	10	1	1	0	0 0	0 4	19 5	2 7	7 4
Jul	28 8	27 0	30 9	26 3	86 0	34 3	6 5	2 7	279 8	561 7	44 5	21 9	0	1	7	12	11	10	5	13	2	1	0	0 0	0 7	20 7	4 1	5 5
Aug	28 9	27 0	31 3	26 2	86 0	34 2	6 2	2 5	283 1	632 2	46 5	18 2	0	1	9	11	10	9	5	15	1	1	0	0 0	0 5	21 3	3 2	6 0
Sep	29 2	26 8	31 7	26 1	83 0	33 4	5 7	2 4	260 2	510 3	48 0	15 5	2	2	9	10	7	7	7	14	1	1	0	0 0	0 4	18 1	3 6	7 9
Oct	28 1	25 3	31 5	24 8	79 0	30 0	4 7	1 8	229 2	605 8	0 0	10 7	4	4	10	6	7	12	7	10	1	1	0	0 0	1 4	18 0	3 4	8 2
Nov	24 7	21 4	29 7	20 7	73 0	23 0	2 9	0 9	61 7	577 6	0 0	9 5	9	5	8	4	4	22	3	5	0	0	0	0 0	0 3	18 5	2 0	9 2
Dec	21 6	18 0	27 6	17 4	70 0	18 0	2 4	0 4	5 8	134 6	0 0	9 4	14	5	6	3	3	27	1	3	0	0	0	0 0	0 0	19 9	1 6	9 5
Annual total or mean	26 9	24 3	30 3	23 7	80 0	29 0	4 1	1 5	1404 4	1984 0	599 9	16 7	80	50	96	79	60	199	54	95	11	6	0	0 2	4 3	229 8	30 9	99 8
Number of Years	30 0	30 0	30 0	30 0	30 0	30 0	29 0	23 0	29 0	89 0	89 0	25 0			27						27					28 0		

CLIMATOLOGICAL TABLE

Station Phulbani

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T-2	3-5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	15 0	12 9	26 6	8 5	77 0	13 4	0 6	0 6	10 8	35 9	0 0	1 6	27	1	1	1	1	27	1	1	1	1	0	0 0	0 4	27 2	3 4	0 0
Feb	18 5	15 5	30 1	11 5	72 0	15 5	0 6	0 6	20 1	98 2	0 0	2 2	25	1	1	0	1	25	1	1	0	1	0	0 2	0 2	24 7	2 9	0 0
Mar	23 3	18 4	34 3	15 3	62 0	17 6	0 6	0 5	19 5	91 0	0 0	2 7	27	1	1	1	1	27	1	1	1	1	0	0 0	0 4	27 7	2 9	0 0
Apr	28 6	21 5	37 9	19 9	53 0	20 4	0 6	0 6	21 0	70 6	1 3	3 8	26	1	1	1	1	26	1	1	1	1	0	0 0	0 0	26 3	3 4	0 3
May	31 1	23 7	39 3	22 9	54 0	23 9	0 8	0 8	40 9	106 8	2 4	3 8	26	1	1	1	2	26	1	1	1	2	0	0 0	0 0	28 2	2 7	0 1
June	28 7	23 9	34 6	23 3	68 0	26 1	3 8	3 7	174 2	375 2	70 1	4 4	12	3	3	2	10	12	3	3	2	10	0	0 0	0 8	27 1	2 1	0 0
Jul	26 0	23 7	29 5	22 2	82 0	27 6	6 0	5 9	362 2	612 2	140 7	4 4	1	5	5	3	17	1	5	5	3	17	0	0 4	1 6	27 0	1 9	0 1
Aug	25 7	23 6	29 2	21 8	83 0	27 5	5 9	5 9	298 0	604 2	77 1	4 0	1	5	6	2	17	1	5	6	2	17	0	0 0	1 7	27 4	1 9	0 0
Sep	25 9	23 6	30 1	21 4	82 0	27 4	4 1	4 1	227 8	451 8	111 8	2 8	7	7	5	2	9	6	7	6	2	9	0	0 0	0 7	27 0	2 0	0 3
Oct	24 0	21 7	30 0	18 7	81 0	24 2	2 4	2 4	81 0	227 4	0 0	1 8	17	4	3	1	6	17	4	3	1	6	0	0 0	0 3	28 3	2 3	0 1
Nov	19 6	17 3	28 1	13 2	79 0	18 2	0 9	0 9	21 7	237 0	0 0	1 4	24	2	1	1	2	24	2	1	1	2	0	0 0	0 1	25 9	3 8	0 2
Dec	15 1	13 0	26 1	8 3	78 0	13 6	0 6	0 6	6 2	46 8	0 0	1 4	27	1	1	0	2	27	1	1	0	2	0	0 1	0 3	27 3	3 2	0 1
Annual total or mean	23 5	19 9	31 3	17 3	73 0	21 3	2 2	2 2	1283 4	1668 1	739 3	2 9	220	32	29	15	69	219	32	30	15	69	0	0 7	6 5	324 1	32 5	1 2
Number of Years	22 0	22 0	22 0	22 0	22 0	22 0	22 0	22 0	21 0	21 0	21 0	22 0			22						22					22 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Bolangir

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb ° C	Wet Bulb ° C	Daily Max ° C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T-2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	19 2	15 6	28 1	15 4	67 0	15 1	1 7	0 9	5 6	32 4	0 0	3 3	23	2	2	2	2	28	1	0	1	1	0	0 2	0 2	3 7	9 1	17 8
Feb	22 3	17 5	31 7	18 9	62 0	16 3	1 5	0 9	17 2	114 0	0 0	4 1	21	1	2	2	2	25	1	0	1	1	0	0 0	0 0	2 2	8 9	16 9
Mar	26 8	20 4	35 9	22 9	54 0	18 9	1 6	0 8	15 0	138 6	0 0	5 4	24	1	2	2	2	29	0	0	1	1	0	0 0	0 1	3 9	8 3	18 7
Apr	31 3	23 5	39 8	27 2	50 0	22 7	1 7	0 7	21 3	62 2	0 0	6 2	18	2	5	3	2	27	0	1	1	1	0	0 0	0 1	0 9	5 3	23 7
May	33 3	25 8	41 6	28 9	54 0	27 2	1 9	1 0	25 5	118 2	0 0	7 4	20	2	4	3	2	25	1	2	1	2	0	0 0	0 1	0 8	5 0	25 1
June	30 5	25 6	36 9	26 6	69 0	29 3	5 0	3 6	185 7	414 6	56 2	7 3	6	1	6	6	11	12	1	3	4	10	0	0 0	0 3	3 1	6 2	20 4
Jul	27 2	25 1	30 9	24 9	84 0	30 2	6 7	5 7	423 6	673 0	227 4	7 1	0	1	5	7	18	5	1	4	5	16	0	0 0	1 0	7 2	6 6	16 2
Aug	27 1	25 0	30 6	24 6	84 0	29 9	6 7	5 8	298 1	494 0	0 0	5 9	1	1	5	6	18	5	1	3	5	17	0	0 0	0 5	7 1	8 7	14 7
Sep	27 4	25 0	31 4	24 9	82 0	29 9	5 3	4 2	206 4	570 0	9 6	5 0	3	2	7	7	11	9	2	5	5	9	0	0 0	0 7	4 1	6 8	18 4
Oct	26 2	23 2	31 3	23 3	76 0	25 9	3 2	2 4	66 3	229 9	0 0	3 9	13	2	6	5	5	18	1	4	3	4	1	0 0	0 3	2 6	5 3	22 8
Nov	22 9	19 3	29 3	19 0	69 0	19 4	21 0	1 1	3 2	72 5	0 0	3 2	17	2	4	4	3	24	1	1	2	2	0	0 0	0 1	1 4	7 3	21 2
Dec	19 4	15 8	27 1	15 3	68 0	15 3	1 8	0 5	4 6	37 8	0 0	2 9	21	1	4	3	2	29	0	0	1	1	0	0 0	0 1	2 4	8 5	20 0
Annual total or mean	26 1	21 8	32 9	22 7	68 0	23 3	3 3	2 3	1289 7	1868 8	843 0	5 1	167	18	52	50	78	236	10	23	30	65	1	0 2	3 5	39 4	86 0	235 9
Number of Years	24 0	24 0	24 0	24 0	24 0	24 0	24 0	22 0	24 0	24 0	24 0	21 0			22						22					22 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Chandball

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb°C	Wet Bulb °C	Daily Max°C	Daily Min° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3-5	6 7	8	0	T 2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	20 2	17 1	26 8	14 3	72 0	17 2	1 3	0 4	11 9	76 8	0 0	5 8	23	2	2	2	2	28	1	1	1	0	0	0 3	0 1	16 6	2 6	11 4
Feb	22 8	19 7	29 8	17 4	74 0	20 6	2 0	1 1	21 8	189 1	0 2	7 3	17	2	3	3	3	22	1	2	2	1	0	0 4	0 3	16 1	0 5	10 7
Mar	26 6	23 1	33 6	21 3	74 0	25 6	2 5	1 3	30 3	129 0	0 0	10 3	16	3	4	5	3	22	2	3	3	1	0	0 1	0 4	16 6	0 7	13 2
Apr	29 3	25 6	36 3	24 6	73 0	29 8	3 0	1 6	38 4	178 8	0 0	14 8	12	3	5	6	4	20	2	3	4	1	0	0 0	0 0	16 3	0 2	13 5
May	30 7	27 0	36 4	26 0	73 0	32 5	3 8	2 4	67 8	471 9	0 0	16 9	8	4	6	8	5	16	3	5	5	2	0	0 0	0 0	16 0	0 3	14 7
June	29 8	27 0	34 3	25 9	80 0	33 3	5 9	3 0	183 3	520 7	50 3	13 0	4	1	4	8	13	12	4	4	5	5	0	0 0	0 1	16 5	0 6	12 8
Jul	28 4	26 6	31 6	25 2	85 0	33 3	6 6	4 0	312 6	644 1	104 4	10 9	1	1	4	9	16	9	4	5	6	7	0	0 0	0 6	16 2	1 0	13 2
Aug	28 4	26 6	31 3	25 4	86 0	33 3	6 3	3 8	345 9	760 4	101 8	10 0	2	1	6	8	14	10	3	7	5	6	0	0 0	0 5	16 0	0 4	14 1
Sep	28 6	26 6	31 6	25 2	84 0	33 1	5 6	3 3	284 3	646 7	79 0	8 6	3	2	6	8	11	10	4	7	5	4	0	0 0	0 5	17 2	0 3	12 0
Oct	27 5	25 1	31 1	23 6	82 0	30 1	3 7	2 1	223 3	647 1	5 6	6 0	10	4	5	5	7	16	4	5	3	3	0	0 0	0 1	19 2	0 3	11 4
Nov	23 8	20 9	29 3	18 6	76 0	22 6	2 0	0 7	43 5	330 2	0 0	5 2	18	3	3	3	3	25	2	1	1	1	0	0 0	0 1	18 7	0 1	11 1
Dec	20 4	17 3	27 1	14 3	71 0	17 3	1 4	0 2	6 3	116 8	0 0	5 1	23	2	2	1	3	31	0	0	0	0	0	0 0	0 1	17 8	0 5	12 6
Annual total or mean	26 4	23 6	31 6	21 8	78 0	27 4	3 7	2 0	1574 3	2335 3	866 5	9 5	137	28	50	66	84	221	30	43	40	31	0	0 8	2 8	203 2	7 5	150 7
Number of Years	30 0	30 0	30 0	30 0	30 0	30 0	30 0	23 0	29 0	49 0	49 0	27 0			28						28					28 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Cuttack

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T 2	3 5	6-7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	19 0	16 7	28 9	15 8	78 0	17 3	1 4	0 5	12 6	81 0	0 0	3 4	22	3	3	1	2	27	1	1	1	1	0	0 3	0 4	1 7	4 6	24 0
Feb	22 1	19 4	32 1	18 7	76 0	20 4	1 9	1 2	23 3	132 8	0 0	4 8	17	3	3	2	3	21	1	2	1	2	1	0 6	0 7	1 3	2 8	22 6
Mar	26 1	22 8	35 7	22 3	74 0	25 1	2 1	1 4	23 6	136 7	0 0	7 0	17	4	5	3	2	23	2	3	2	1	0	0 3	0 4	1 3	1 7	27 3
Apr	29 4	25 4	38 2	25 2	71 0	29 2	2 5	1 6	27 1	151 6	0 0	9 9	12	5	7	4	2	21	2	3	3	1	0	0 0	0 3	1 0	1 2	27 5
May	31 1	26 8	38 9	26 7	70 0	31 8	3 2	1 8	69 7	483 1	2 4	10 8	8	6	9	5	3	18	3	5	3	2	0	0 0	0 1	0 7	1 6	28 6
June	30 1	26 6	36 0	26 3	76 0	32 1	5 5	3 4	197 6	586 7	26 7	8 1	1	3	9	6	11	- 14	2	5	3	6	0	0 0	0 4	1 8	4 2	23 6
Jul	28 4	26 1	32 3	25 4	83 0	32 1	6 2	4 2	326 4	680 5	99 3	7 4	1	2	7	7	14	10	2	6	4	9	0	0 0	0 3	3 1	7 0	20 6
Aug	28 2	26 1	32 0	25 4	84 0	32 2	6 0	4 0	340 7	901 7	113 6	6 6	1	2	7	7	14	11	2	6	4	8	0	0 0	0 5	3 8	8 4	18 3
Sep	28 5	26 1	32 5	25 3	82 0	32 0	4 9	3 0	260 4	766 1	53 1	6 2	3	4	8	7	8	13	3	6	3	5	0	0 0	0 4	2 0	5 0	22 6
Oct	27 3	24 6	32 4	23 6	79 0	28 8	3 2	1 9	166 4	493 8	0 0	5 1	10	5	6	5	5	19	3	4	2	3	0	0 0	0 2	1 2	4 0	25 6
Nov	23 4	20 4	30 6	19 3	74 0	21 7	1 8	0 7	23 6	267 7	0 0	3 8	17	4	4	2	3	26	1	1	1	1	0	0 1	0 1	1 6	2 4	25 8
Dec	19 5	16 9	28 7	15 6	74 0	17 0	1 2	0 3	3 9	96 0	0 0	3 1	23	3	2	2	1	30	0	1	0	0	0	0 1	0 3	1 2	3 3	26 0
Annual total or mean	26 1	23 2	33 2	22 5	77 0	26 6	3 3	2 0	1475 3	2364 3	884 8	6 4	132	44	70	51	68	233	22	43	27	39	1	1 4	4 1	20 7	46 2	292 6
Number of Years	30 0	30 0	30 0	30 0	30 0	30 0	30 0-	25 0	29 0	99 0	99 0	30 0			27						27					27 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Gopalpur

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min °C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T-2	3 5	6-7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	20 5	17 8	27 3	16 5	75 0	18 3	1 8	0 5	16 6	113 2	0 0	9 8	14	7	5	4	1	26	4	1	0	0	0	0 1	1 1	21 7	7 2	0 9
Feb	23 4	20 4	29 2	19 3	75 0	21 7	1 8	0 9	17 7	197 6	0 0	12 2	12	7	5	3	1	18	6	3	1	0	0	0 0	1 3	19 1	7 4	0 2
Mar	26 4	23 4	30 6	22 3	77 0	26 4	1 8	0 7	16 2	190 7	0 0	16 6	15	7	5	3	1	20	7	3	1	0	0	0 2	1 9	21 9	6 8	0 2
Apr	28 0	25 7	31 1	24 7	82 0	31 1	2 5	0 6	18 9	153 8	0 0	21 0	9	8	7	5	1	22	6	2	0	0	0	0 1	2 5	21 5	5 7	0 2
May	29 6	27 2	32 3	26 4	82 0	34 0	3 8	1 2	33 8	331 2	0 0	21 7	4	6	10	8	3	17	7	6	1	0	0	0 2	3 0	22 7	4 6	0 5
June	29 6	27 3	32 3	26 6	83 0	34 3	6 1	2 1	137 4	405 4	12 2	17 7	0	2	6	13	9	10	9	10	1	0	0	0 0	2 8	22 3	4 3	0 6
Jul	28 4	26 4	31 0	25 7	85 0	32 9	6 7	2 7	197 9	545 6	18 3	15 9	0	1	4	14	12	6	10	13	2	0	0	0 0	2 3	22 7	5 5	0 5
Aug	28 5	26 4	31 3	25 7	84 0	32 7	6 6	2 6	218 2	528 8	26 4	13 1	0	1	5	15	10	5	10	14	2	0	0	0 0	2 0	23 0	5 2	0 8
Sep	28 5	26 2	31 8	25 4	83 0	32 4	5 9	2 2	206 8	502 4	40 2	11 4	1	2	7	13	7	7	11	10	2	0	0	0 0	1 6	21 4	5 7	1 3
Oct	27 0	24 7	31 3	23 6	83 0	29 4	4 3	1 9	302 8	737 6	0 0	10 0	3	6	8	9	5	11	10	7	3	0	0	0 0	1 6	22 0	5 5	1 9
Nov	23 5	20 8	29 7	19 4	77 0	22 5	3 0	1 0	73 3	572 3	0 0	9 6	8	7	6	6	3	19	6	4	1	0	0	0 0	0 8	19 8	7 3	2 1
Dec	20 5	17 7	27 8	16 4	75 0	18 2	2 2	0 3	9 7	236 5	0 0	9 9	14	7	5	4	1	27	3	1	0	0	0	0 0	1 0	21 2	8 1	0 7
Annual total or mean	26 2	23 7	30 5	22 7	80 0	27 8	3 9	1 4	1264 6	2040 9	655 1	14 1	80	61	73	97	54	188	89	74	14	0	0	0 6	21 9	259 3	73 3	9 9
Number of Years	30 0	30 0	30 0	30 0	30 0	30 0	30 0	20 0	30 0	100 0	100 0	27 0			23						23					23 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Hirakud

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph	0	T 2	3-5	6 7	8	0	T-2	3 5	6 7	8	FOG 8	Upto 1 Km	1-4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	19 0	15 4	27 7	14 2	66 0	14 6	1 6	0 4	11 0	45 6	0 0	2 7	19	5	4	2	1	26	2	2	1	0	0	0 3	3 4	12 3	13 9	1 1
Feb	22 0	16 9	30 9	16 7	58 0	15 2	1 3	0 4	20 1	122 2	0 0	3 1	19	4	3	1	1	24	2	2	0	0	0	0 0	1 7	10 9	13 1	2 3
Mar	26 3	19 3	35 1	20 6	50 0	16 8	1 6	0 5	29 0	114 9	0 0	3 5	20	4	3	3	1	26	2	2	1	0	0	0 0	1 7	11 5	15 6	2 2
Apr	30 8	22 4	39 2	25 2	46 0	20 2	1 8	0 3	16 8	43 4	0 0	4 4	14	7	5	3	1	24	4	2	0	0	0	0 0	0 8	8 2	19 4	1 6
May	33 0	24 6	41 4	28 2	49 0	24 2	1 8	0 5	17 2	51 0	0 0	5 3	13	10	5	2	1	23	5	3	0	0	0	0 0	0 2	8 3	20 5	2 0
June	30 2	25 3	36 8	27 1	68 0	28 3	5 1	2 3	215 7	511 4	60 8	6 5	1	4	8	10	7	7	8	12	2	0	0	0 0	1 2	7 4	14 5	6 9
Jul	27 4	25 4	31 4	25 2	84 0	30 7	6 5	3 8	461 3	924 1	237 6	5 8	0	1	6	11	13	2	6	13	9	1	0	0 1	3 6	9 4	10 8	7 1
Aug	27 3	25 5	31 0	25 1	85 0	31 0	6 4	3 8	481 3	875 8	219 2	5 1	1	2	5	12	11	3	7	14	7	0	0	0 4	2 6	11 1	11 8	5 1
Sep	28 0	25 4	32 1	25 0	80 0	30 1	4 8	3 0	285 7	696 7	68 6	4 3	2	6	7	10	5	4	10	10	6	0	0	0 2	1 7	9 3	12 3	6 5
Oct	27 0	23 4	31 9	22 8	72 0	25 9	2 7	1 2	74 6	191 1	0 6	3 6	12	7	5	5	2	17	8	5	1	0	0	0 1	0 8	6 7	19 1	4 3
Nov	23 5	19 3	29 7	17 7	65 0	19 1	1 4	0 5	2 9	21 2	0 0	2 9	14	8	4	3	1	24	3	2	1	0	0	0 0	0 6	12 7	12 8	3 9
Dec	19 7	15 9	27 3	13 9	65 0	15 1	14 0	0 3	3 8	33 8	0 0	2 4	18	7	3	2	1	27	2	1	1	0	0	0 0	2 3	15 2	10 8	2 7
Annual total or mean	26 2	21 6	32 9	21 8	66 0	22 6	3 0	1 4	1635 7	2963 4	1136 7	4 1	133	65	58	64	45	207	59	68	30	1	0	1 1	20 6	123 0	174 6	45 7
Number of Years	21 0	21 0	21 0	21 0	22 0	21 0	21 0	17 0	22 0	22 0	22 0	21 0			14						14					14 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Month	Station Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T 2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	16 7	13 4	27 7	12 0	67 0	12 8	1 7	0 5	12 5	61 4	0 0	5 6	16	6	5	3	1	26	3	2	0	0	0	0 1	0 3	22 9	7 4	0 3
Feb	20 1	15 1	30 8	14 7	57 0	13 2	1 7	0 6	18 0	116 7	0 0	6 3	16	5	4	2	1	23	3	2	0	0	0	0 0	0 1	19 2	8 7	0 0
Mar	25 4	17 6	35 5	19 0	44 0	14 0	1 8	0 5	21 0	97 8	0 0	6 9	18	5	4	3	1	26	3	2	0	0	0	0 0	0 4	22 1	8 1	0 4
Apr	30 8	21 3	40 1	24 2	41 0	17 7	2 1	0 5	13 8	58 9	0 0	7 5	13	6	6	4	1	24	4	2	0	0	0	0 0	0 3	19 2	9 6	0 9
May	32 9	23 9	41 8	27 1	46 0	22 3	2 5	0 6	29 9	107 8	0 0	8 0	9	9	8	4	1	22	6	3	0	0	0	0 0	0 1	18 7	12 1	0 1
June	30 2	25 0	37 2	26 4	66 0	27 4	5 9	2 5	228 7	524 9	42 2	9 3	1	2	7	11	9	8	8	10	4	0	0	0 0	0 2	19 3	10 2	0 3
Jul	26 9	25 0	31 3	24 6	86 0	30 2	7 2	4 3	402 7	770 7	230 9	9 0	0	0	3	11	17	1	4	17	9	0	0	0 0	1 9	21 8	7 2	0 1
Aug	26 8	25 1	31 0	24 5	87 0	30 6	7 2	4 3	428 5	657 9	212 1	8 3	1	0	0	3	11	16	1	4	17	9	0	0 0	0 8	22 0	8 0	0 2
Sep	27 2	25 0	31 8	24 3	83 0	29 9	6 0	3 2	233 1	714 5	42 5	6 8	0	2	7	12	9	4	7	14	5	0	0	0 0	0 3	19 0	10 6	0 1
Oct	25 7	22 6	31 9	21 6	75 0	24 9	3 6	1 5	65 0	181 5	0 2	5 5	9	5	7	7	3	16	6	7	2	0	0	0 0	0 2	20 9	9 8	0 1
Nov	21 3	17 4	30 0	16 0	66 0	17 0	2 1	0 5	4 3	28 7	0 0	5 7	14	6	5	4	1	24	4	2	0	0	0	0 0	0 2	21 9	7 7	0 2
Dec	17 2	13 8	27 6	12 0	67 0	13 2	1 8	0 3	3 4	22 0	0 0	5 3	15	6	6	3	1	28	2	1	0	0	0	0 0	0 5	26 4	4 1	0 0
Annual total or mean	25 1	20 4	33 1	20 5	65 0	21 1	3 6	1 6	1460 9	2656 6	901 0	7 0	112	52	65	75	61	203	54	79	29	0	0	0 1	5 3	253 4	103 5	2 7
Number of Years	30 0	30 0	28 0	28 0	30 0	30 0	30 0	23 0	30 0	30 0	30 0	28 0			27						27					27 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Koenjhargarh

Month	Mean Dry bulb °C	Mean Wet Bulb °C	Daily Max °C	Daily Min °C	Humidity		Cloud Amount		Monthly total mm	Rainfall		
					Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds		Total in Wettest Month with year mm	Total in Driest Month with year mm	Mean wind speed Kmph
Jan	17 4	13 8	26 0	11 4	66 0	13 3	1 1	0 8	11 7	50 6	0 0	3 5
Feb	20 4	15 5	29 0	14 3	61 0	14 3	0 9	0 7	22 6	193 9	0 0	4 6
Mar	24 7	18 5	33 5	18 7	56 0	16 9	1 0	0 7	28 6	107 8	0 0	5 0
Apr	28 7	21 7	37 3	22 4	55 0	21 1	1 3	0 9	32 4	73 8	0 0	6 3
May	29 9	24 0	38 3	24 5	62 0	25 4	1 5	1 0	70 9	142 2	5 9	7 0
June	28 3	24 4	34 7	24 1	73 0	27 8	3 9	3 1	169 6	322 0	20 3	7 8
Jul	26 0	24 0	30 1	23 1	84 0	28 2	5 5	5 0	251 9	435 3	145 0	7 4
Aug	25 7	23 9	29 8	23 2	86 0	28 4	5 4	4 8	309 2	529 6	132 6	6 4
Sep	25 7	23 8	30 2	22 6	85 0	28 0	4 5	3 8	262 5	650 7	151 4	5 4
Oct	24 3	21 7	29 8	20 1	80 0	24 3	2 7	2 5	90 9	297 0	0 0	4 6
Nov	20 9	17 2	27 6	15 6	69 0	17 0	1 5	1 2	12 7	51 0	0 0	3 5
Dec	17 7	14 0	25 7	11 8	66 0	13 3	1 0	0 5	6 1	36 2	0 0	3 4
Annual total or mean	24 1	20 2	31 0	19 3	70 0	21 5	2 5	2 1	1269 1	1909 5	665 0	5 4
Number of Years	24 0	24 0	24 0	23 0	24 0	24 0	24 0	23 0	23 0	23 0	23 0	22 0

Month	No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	0	T 2	3 5	6-7	8	0	T 2	3 5	6 7	8	FOG 8	Upto 1 Km	1-4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	23	3	3	1	1	24	3	2	1	1	0	0 0	0 9	28 0	0 6	1 5
Feb	22	2	2	1	1	24	1	1	1	1	0	0 0	0 8	24 5	0 1	2 6
Mar	24	2	3	2	0	25	2	3	1	0	0	0 1	0 3	28 4	0 4	1 8
Apr	20	3	4	3	0	23	3	3	1	0	0	0 0	0 5	27 7	0 0	1 8
May	21	3	5	2	0	23	3	4	1	0	0	0 0	0 4	26 0	0 1	4 5
June	9	2	8	6	5	11	3 0	8	5	3	0	0 1	2 3	25 0	0 1	2 5
Jul	2	1	9	11	8	3	2	11	9	6	0	0 1	3 7	24 2	0 0	3 0
Aug	3	2	8	10	8	3	3	11	8	6	0	0 2	3 7	24 3	0 1	2 7
Sep	5	2	9	8	6	5	4	11	5	5	0	0 2	2 7	25 0	0 0	2 1
Oct	13	4	5	5	4	15	4	5	4	3	0	0 0	2 2	26 9	0 0	1 9
Nov	20	3	4	2	1	20	3	4	2	1	0	0 1	0 6	26 1	1 3	1 9
Dec	23	3	3	1	1	26	2	2	1	0	0	0 0	0 6	29 0	0 4	1 0
Annual total or mean	185	30	63	52	35	202	33	65	39	26	0	0 8	18 7	315 1	3 1	27 3
Number of Years			23						23					23 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Koraput

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T 2	3-5	6-7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 K
Jan	16 7	13 4	24 8	10 9	68 0	13 0	1 5	0 6	6 3	53 3	0 0		19	5	3	2	2	27	1	1	1	1	0	0 1	0 2	0 6	3 5	26 6
Feb	19 4	15 2	28 0	13 7	64 0	14 2	1 3	0 4	2 5	18 2	0 0		19	4	3	1	1	24	1	1	1	1	0	0 0	0 0	0 2	1 4	26 4
Mar	23 1	17 8	31 6	17 4	59 0	15 9	1 3	0 6	18 1	85 0	0 0		25	2	2	1	1	27	1	2	1	0	0	0 0	0 1	0 8	3 3	26 8
Apr	25 2	19 9	33 3	20 5	62 0	19 5	2 0	0 9	50 5	135 2	1 5		16	4	6	3	1	24	2	3	1	0	0	0 0	0 6	1 5	4 8	23 1
May	26 8	21 2	34 2	22 0	60 0	21 2	1 8	1 2	73 4	201 5	0 0		14	5	6	2	4	23	2	3	1	2	0	0 0	0 1	1 5	4 1	25 3
June	24 6	21 1	30 7	21 3	73 0	22 4	5 3	3 4	209 9	451 6	27 7		4	2	9	5	10	9	3 0	7	3	8	0	0	1 2	4 6	7 2	17 0
Jul	22 1	20 5	25 5	19 4	87 0	23 7	6 4	4 8	401 7	872 8	64 5		2	1	7	6	15	6	2	6	4	13	0	0 4	2 4	6 5	10 9	10 8
Aug	22 2	20 6	25 7	19 2	87	23 8	6 0	4 0	359 9	745 5	130 3		3	1	8	5	14	6	3	7	4	11	0	0 9	1 5	7 0	10 0	11 6
Sep	22 6	20 9	26 5	19 3	86 0	23 9	5 0	3 3	232 7	438 3	58 3		3	3	9	7	8	10	3	7	4	6	0	0 5	0 6	3 5	8 1	17 3
Oct	22 0	19 6	26 8	17 9	80 0	21 2	3 3	1 7	92 7	259 7	3 2		9	5	9	3	5	16	4	6	2	3	0	0 1	0 5	2 1	6 3	22 0
Nov	19 1	16 1	25 2	13 7	73 0	15 9	2 2	1 2	26 2	146 2	0 0		16	4	5	2	3	21	2	4	2	1	0	0 2	0 1	1 0	3 8	24 9
Dec	16 9	13 8	24 3	10 8	71 0	13 5	1 5	0 6	3 4	43 5	0 0		22	4	3	1	1	26	1	2	1	1	0	0 0	0 3	0 5	2 6	27 6
Annual total or mean	21 7	18 3	28 1	17 2	73 0	19 0	3 2	1 9	1550 8	2168 0	889 3		152	40	70	38	65	219	25	49	25	47	0	2 2	7 6	29 8	66 0	259 4
Number of Years	26 0	26 0	26 0	24 0	26 0	25 0	26 0	18 0	28 0	28 0	28 0				23				23							23 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Paradip Port

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb ° C	Wet Bulb ° C	Daily Max ° C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6 7	8	0	T 2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	21 3	18 7	27 7	15 3	77 0	19 7	0 7	0 3	17 6	62 7	0 0	12 3	25	3	2	1	0	29	1	1	0	0	0	0 3	1 8	11 4	2 2	15 3
Feb	24 1	21 4	29 1	18 3	78 0	23 2	1 3	0 7	6 5	26 0	0 0	14 7	17	4	5	2	0	21	4	3	0	0	0	0 6	0 3	10 8	3 3	13 0
Mar	27 3	24 6	31 2	22 0	79 0	28 5	1 8	1 1	26 7	141 0	0 0	18 0	17	5	6	3	0	20	5	5	1	0	0	0 0	0 2	10 3	5 5	15 0
Apr	28 9	26 5	32 0	24 6	82 0	32 6	2 2	1 3	23 5	120 8	0 0	22 7	15	5	6	3	1	16	7	5	1	1	0	0 0	0 2	10 5	7 3	12 0
May	30 0	27 5	33 1	25 8	82 0	34 5	2 7	1 6	54 3	170 8	0 0	23 9	11	5	8	5	2	16	7	6	2	0	0	0 0	0 3	10 0	8 9	11 8
June	29 7	27 3	32 7	26 2	83 0	34 4	4 5	2 4	225 7	609 2	20 8	21 1	5	3	9	8	5	10	6 0	11	3	0	0	0 1	1 9	13 3	8 2	6 5
Jul	28 5	26 6	31 5	25 3	86 0	33 4	5 6	3 0	329 3	633 5	141 5	20 5	1	2	10	10	8	6	7	14	4	0	0	0 0	4 0	14 5	9 0	3 5
Aug	28 6	26 7	31 3	25 5	86 0	33 5	5 2	3 0	345 9	576 3	115 8	18 6	4	2	9	9	7	8	6	13	4	0	0	0 1	3 6	13 7	9 6	4 0
Sep	29 0	26 7	32 0	25 6	83 0	33 3	4 5	2 7	242 9	349 8	86 0	18 0	3	4	9	9	5	9	6	12	3	0	0	0 1	1 8	10 7	10 7	6 7
Oct	28 3	25 8	31 7	24 3	81 0	31 1	2 8	1 9	206 3	452 5	106 6	11 7	11	6	7	5	2	14	7	8	2	0	0	0 0	1 2	8 8	11 5	9 5
Nov	25 6	22 9	30 2	20 5	79 0	26 1	2 2	0 9	108 7	334 4	0 0	10 8	16	4	4	4	2	22	4	3	1	0	0	0 0	1 3	8 4	8 6	11 7
Dec	21 7	19 0	28 0	15 3	76 0	20 1	1 0	0 2	21 7	261 0	0 0	10 0	24	2	2	2	1	29	1	1	0	0	0	0 0	1 0	12 4	2 6	15 0
Annual total or mean	26 9	24 5	30 9	22 4	81 0	29 2	2 9	1 6	1661 6	2150 6	1232 3	16 9	149	45	77	61	33	200	61	82	21	1	0	1 2	17 6	134 8	87 4	124 0
Number of Years	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	15 0	15 0	15 0	12 0			12						12					12 0		

Annexure 5 contd

CLIMATOLOGICAL TABLE

Station Titlagarh

Month	Mean				Humidity		Cloud Amount		Rainfall				No of days with cloud Amount (All clouds) Oktas					No of days with low cloud amount Oktas						No days with visibility				
	Dry bulb °C	Wet Bulb °C	Daily Max °C	Daily Min ° C	Relative humidity %	Vapour Pressure hPa	All clouds	Low clouds	Monthly total mm	Total in Wettest Month with year mm	Total in Dnest Month with year mm	Mean wind speed Kmph	0	T 2	3 5	6-7	8	0	T 2	3 5	6 7	8	FOG 8	Upto 1 Km	1 4 Kms	4 10 Kms	10 20 Kms	Over 20 Km
Jan	19 3	15 2	29 5	13 5	63 0	14 0	2 2	0 4	9 3	58 1	0 0	2 5	14	3	12	2	0	28	1	2	0	0	0	0 4	6 2	5 2	14 6	4 6
Feb	22 6	17 2	33 0	16 5	58 0	15 6	2 1	0 3	11 9	83 5	0 0	2 8	13	3	10	2	0	26	1	1	0	0	0	0 0	5 1	4 5	14 3	4 1
Mar	26 7	20 0	37 1	20 6	52 0	17 7	1 9	0 3	24 9	141 2	0 0	3 5	15	3	11	2	0	28	2	1	0	0	0	0 0	3 7	5 6	16 4	5 3
Apr	30 4	22 6	40 5	24 2	51 0	20 9	2 1	0 3	18 9	56 7	0 0	4 1	14	4	10	2	0	26	3	1	0	0	0	0 0	3 3	4 4	16 5	5 8
May	32 7	24 3	42 7	26 8	49 0	23 7	2 3	0 4	32 5	150 6	0 0	4 2	13	4	11	3	0	26	3	2	0	0	0	0 0	3 5	4 6	15 5	7 4
June	29 4	24 4	38 5	25 4	67 0	26 4	4 4	1 3	203 2	476 8	46 5	4 7	4	2	12	9	3	15	7 0	6	1	1	0	0 3	3 2	8 3	14 4	3 8
Jul	26 6	24 3	32 5	24 1	82 0	28 4	5 5	2 2	396 0	679 0	126 0	4 3	1	1	9	14	6	9	9	10	1	2	0	0 4	4 5	12 0	11 9	2 2
Aug	26 4	24 3	31 7	24 0	83 0	28 7	5 6	2 1	382 5	791 4	87 7	3 6	0	1	11	13	6	10	8	9	2	2	0	0 0	4 8	9 4	14 3	2 5
Sep	27 0	24 5	32 2	24 0	81 0	28 8	4 7	1 4	229 7	614 4	80 8	3 2	2	3	13	9	3	14	7	7	1	1	0	0 0	2 6	8 8	15 7	2 9
Oct	26 1	23 3	32 7	22 3	78 0	26 4	3 5	0 6	80 8	258 1	7 3	2 8	5	4	16	5	1	22	5	4	0	0	0	0 7	1 4	6 7	17 4	4 8
Nov	22 2	18 8	30 7	17 0	71 0	19 1	2 5	0 2	9 4	58 0	0 0	2 6	9	5	13	2	1	27	2	1	0	0	0	1 4	2 1	4 1	16 7	5 7
Dec	18 9	15 3	29 0	13 1	67 0	14 7	2 2	0 2	4 7	59 3	0 0	2 4	13	3	13	2	0	29	1	1	0	0	0	1 6	3 5	4 4	16 1	5 4
Annual total or mean	25 7	21 2	34 2	21 0	67 0	22 0	3 3	0 8	1429 6	2034 5	723 9	3 4	103	36	141	65	20	260	49	45	5	6	0	4 8	43 9	78 0	183 8	54 5
Number of Years	30 0	30 0	30 0	30 0	30 0	30 0	30 0	23 0	30 0	36 0	36 0	30 0			28						28					28 0		

Annexure:6 Household Level Questionnaire

Date:

Household details

1. Head of the family: ______________ Caste:

2. No. of family members:

M	**F**	**CM(<15)**	**CF(<15)**	**Total**

M-male, F-female, CM-child male, CF-child female

3. Literate:

M	**F**	**C**

M-male, F-female, C-children

4. Family structure: Nuclear/Joint

5. Family Income:

Occupation	**Monthly income**
Service	
Agriculture	
Cattle Rearing	
Labour	
Wood selling	
Business	
NTFP	
Total	

6. **Agriculture Details:**

Total Land (acres): ________ Cultivated land (acres): __________

Irrigated Area

Annexure 6 contd

7. Crop Details

Crop	Area (Acres)	Yield (Qtls/Acre)
Paddy		
Maize		
Ragi		
Millets		

8. Livestock details:

	Numbers	Income per year
Buffaloes		
Bullocks		
Cows		
Calves		
Goats/sheeps		
Others		

9. Household details:

a. No of lighting device used/day ________________

b. Traditional devices used for lighting and numbers: HL(____), KL(____), BL(____)

c. Type of house: Pucca/Semi-pucca/Kachcha

d. Type of roof: Thatched/tile/concrete

e. No. of rooms: 1/2/3/4/5/more (including kitchen)

f Drinking water source: __________________ Distance _______

Annexure 6 contd

10. Cooking devices (in nos.):

TC	**IC**	**Kerosene stove**	**LPG**	**Any other**

TC- traditional cookstove, IC-improved cookstove

11. Fuel consumption in cooking and lighting:

Activity	**Fuel**	**Summer**	**Winter**
Cooking	DC(kg/day)		
	Fuelwood (kg/day)		
	CR(kg/day)		
	Kerosene(lit/day)		
	LPG (cyl/month)		
	Biogas		
Lighting	Kerosene (lit/month)		
	Electricity (Rs/month)		

DC- dungcakes, CR- crop residues

12. Crop residue usage detail (%)

Fuel	Cooking	Fodder	Construction / Roofing	Manure	Wastage
Crop residues					
Paddy Straw					
Paddy Husk					
Maize straw					
Maize cob					
Ragi straw					

Annexure 6 contd

13. Fuel collection pattern

Fuel	**Source**	**Specific months**	**Trips/ month**	**Kg/trip**	**Distance**
Fuel wood					
Dung					
Crop residue					
Kerosene					
LPG ·					

14. If Purchase:

Fuel	**Source**	**Distance**	**Quantity/ month**	**Rate (Rs)**	**Amount**
Fuel wood					
Dung cake					
Kerosene					
LPG					
Other					
LPG					
Other					

15. Other activities:

a) Are you aware about fuel-efficient technologies: Yes/No

b) Would you like to adopt fuel-efficient tech for lighting purposes: Yes/No

c) Total lighting requirement: one point/ two point/ power for income generating activity

d) Willingness to contribute for light in (Rs/Month):

e) Preference and purposes of better light:

Annexure 6 contd

Biomass estimation

1. Total forest area..............................
2. Area under tree...............................
3. Area under social forestry......................
4. Production per hectare...........................
1. Tree species

Tree species	Usage	No of plants per ha.	Average height
1		10-20 20-40 40-60 >60	1 2 3
2		10-20 20-40 40-60 >60	1 2 3
3		10-20 20-40 40-60 >60	1 2 3
4		10-20 20-40 40-60 >60	1 2 3
5		10-20 20-40 40-60 >60	1 2 3
Shrubs species for fuel puposes		No of plants per 10m X 10m	Height
1			
2			
3			
4			
5			

Annexure 7: Feasibility Study on Popularization of Oil-Replacement Energy in Orissa

Tata Energy Research Institute, New Delhi

Village check list

1. General information	**1.**	**2.**
Name of the village		
Name of the revenue village		
Gram Panchyat		
Block Name		
2. Household and village detail		
Total Households		
General caste		
ST family		
SC family		
BPL family		
Average family size		
Percentage of literacy		
Average family income		
Distance from the nearest Power line		
Distance from metal road		
Distance of nearest petrol pump		
Distance from Block Head Quarter		
3. Land Classification (From the RI /Panchayat Office)		
Forest land (ha)		
Net cultivable land (ha)		
Irrigated land (ha)		
Un-irrigated land (ha)		
Fallow land (ha)		
Barren land (ha)		
Pasture land (ha)		
Cultivable waste land		
Other land (ha)		
Total land (ha)		
4. Land Holding Size (HH):		
Large farmer >10 acre		
Medium farmer 5-10 acre		
Small farmer 2.5-5 acre		
Marginal farmers <2.5 acre		
Land less		

Annexure 7. contd

5. Livestock population				
Total cows (Nos.)				
Bullocks (Nos.)				
Pigs (Nos.)				
6. Biomass production detail-2000	**Area (ha)**	**Yield q/ha**	**Area (ha)**	**Yiel**
• Paddy • Millet • Ragi • Sugarcane • Any other crop				
Forest area under tree cover (ha)				
Production (per hectare)				
Area under shrubs (ha)				
Area under social forestry				
Production (per hectare)				
7. Biomass supply details				
Distance covered for wood collection (km)				
Weight of head-load (kg)				
No of trips made/week /family				
No of families are selling wood				
Wood sold in (Kg/ Week)				
8. Fuel Distribution Pattern				
Usage of wood				
Usage of Dung Cake				
Usage of Kerosene				
Usage of diesel				
Usage of Crop Residue				
Cooking (%)				
For thatch (%)				
For cattle feeding (%)				
Remaining surplus CR (%)				
9. Cost of Available Biomass/Fuel				
Wood (Rs/ bundle)				
Paddy residue(Rs/Quintal)				
Millet residue(Rs/Quintal)				
Kerosene (Rs/lit)				
LPG cylinder (Rs)				

Annexure 7. contd

Diesel (Rs/Lit)		
10. Water Supply		
Source of water		
No. pumpsets for water supply		
Type (Diesel/Kerosene)		
Capacity		
Fuel Consumption per hour		
No. of Hours and time used/Day		
Distance from the village to site		
11. Other information		
Labour cost-general (Rs/day)		
Agriculture labour cost (Rs/day)		
12. Transportation availability		
Tractor- rate Rs/ day		
Bullock cart Rs/ day		
By Head Load (Rs./Day)		
13. Lighting Requirement and Uses		
Uses of Light		
Monthly Expenses for Home lighting per family		
Lighting devices		
Requirement of better light?		
Purposes of better light		
14. Willingness to spend for better lighting		
Beneficiary share for one point (Rs/month.)		
Beneficiary share for two point (Rs/month.)		
Beneficiary share for other use (Rs/month.)		
Required no. of points in villages		
Lighting Hours required / day		
Load Required for pumping		
Pump running hours /day		
Total Load Required		
15. Economic activity (lighting Options)		
Income generating activities		
Fair price shop (no. of points required)		
Primary school (no. of points required)		
Community Hall (no. of points required)		
Primary Health Center (No. of Point required)		
Flour mill (Load)		

Annexure7. contd

Diesel consumption per day –liters		
Rice mill (Load)		
Diesel consumption day –liters		
Oil processing (Load)		
Smithy (No. of points)		
Fuel used per month		
16. Institutions		
Present gram panchyat and activity in the village		
Cooperative society and activity		
Can they are interested to manage gasifier and how		
Possible income generation activities for electrification	1 2 3	1 2 3

17. Observation

Main crops: (From – village level)

Crop	**Production / acre**	**Grain : residue**	**Crop period**	**Use of surplu CR**

Annexure 8. Calculation of sustainable yield of woody biomass and shrubs

Woody biomass

Different types of tree species were identified. The girth at breast height (GBH) for sample trees was measured. The height of trees were measured by the *Abney,s Hand Level*. GBH and height of the trees were used to calculate the volume of the trees. The following equations were used to formulate the regression equation for height and volume (Chaturvedi, 1984).

i) $H = a + b \times G$
ii) $V = a + b \times G * G \times H$ and
iii) $V = a + b \times D * D \times H$

Where V is the volume (in cu. m), H is height (in m), G is Girth at Breast Height (GBH) (in m), D is diameter at breast height (DBH) (in m), a and b are regression constants.

Woody volume computed in terms of cubic meter was converted to ton by the following standard conversion:

1.5 cu. m. = 1 tonne

Volume generated by the woody species under different land categories was aggregated to compute the total growing stock in the village. Van Montal's fomula (Davis,1996)* was used to calculate the annual sustainable yield:

$$Y = \frac{2GS}{R}$$

Where Y is sustainable yield (ton/year), GS is growing stock (ton) and R is the rotation of growing stock in the villages (average 30 year).

Shrubs

To estimate the biomass from the different areas, three quadrates, 10m X 10m were laid in different sites. The growing stock is calculated on the basis of regression equation. The average growing stock is 101.63 ton/ha and sustainable yield 6.7 ton/ha. Same method was adapted to estimate the shrub biomass from different area. The GS of *Lantana* is 0.8 ton/ha.

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